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THE 3-D GENERAL GEOMETRY PIC SOFTWARE FOR DISTRIBUTED MEMORY MIMD COMPUTERS:

TASK 1 FINAL REPORT

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September 1994

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September 1994

Abstract

This document, together with the software and test datasets supplied and installed on a SUN workstation at Phillips Laboratory are the completion of Task 1 of the contract 3-D PIC Software for MIMD Computers, PIIN:F61708-93-C0011.

1 INTRODUCTION

The contents of this document and its Appendices and Annexes describe the software and test datasets for Task 1 of the contract *3-D PIC Software for MIMD Computers, PIIN:F61708-93-C0011.* Further details on the algorithms and software design are given in earlier documents issued during this contract [10, 11, 12, 13, 14, 16], and during earlier studies[3, 4].

The objectives of the work, as stated in the contract, are

Task 1: The primary target for the present proposal is to implement a fully three dimensional time domain electromagnetic field solver code using body-fitted brick finite elements. The code will be Fortran based, and designed to run efficiently on distributed memory MIMD computers.

Task 2: Task 2 will extend the code developed in Task 1, adding particle integration modules to the electromagnetic solver to create a 3-D general geometry PIC code.

As described in the original proposal [5], the method of achieving these objectives has been based on that used for the two dimensional benchmarking program [4] developed under Air Force Office of Scientific Research (AFSC) Contract F49620-92-C-0035. Only Task 1 was scheduled to be undertaken in the present phase of the work, although some of the Task 2 items have been started to help achieve the goals of Task 1.

The numerical algorithms used in the electromagnetic software are based on those described in Reference [3]. In summary, these use

1. the 'Virtual Particle' derivation method [2] applied to tensor field components,
2. a multiblock spatial decomposition applied to both fields and particles,
3. transfinite interpolation subdivision of the curvilinear hexahedral multiblocks into hexahedral elements,
4. indirect ("glue patch") addressing between multiblocks, and logical cubical mesh (i,j,k) node addressing within blocks,
5. lumped approximations to the finite element equation [3].

The initially proposed scheme has evolved a little in the light of experience, as will be apparent from the material presented in this report and its Annexes.

Task 1: Electromagnetic Software The stated goals of the first part of the contract were [5] :

Subtask 1.1 Identify and evaluate the mesh generation software to be used. Specify its interface to the electromagnetic software.

Subtask 1.2 Prepare a document containing the specification of the software and validation test cases. Agree specifications with USAF technical contract monitor.

Subtask 1.3 Write the 3-D electromagnetic solver program.

Subtask 1.4 Execute test cases on SUN SPARCstation and on the agreed distributed memory MIMD computer.

Subtask 1.5 Deliver documented software and test run input and output to Phillips laboratory.

Subtasks 1.1 and 1.2 have been documented in earlier reports [10, 11, 12, 13] issued under this contract. Annexes B, C, D, F and G update and extend the specifications. The remaining activities undertaken to satisfy the requirements of Subtasks 1.3-1.5, and to undertake some preparatory work for Task 2 are outlined in this document and its Annexes.

The Appendices to this report contain a list of the program units, and some fragments of the units and integration test outputs used in developing and verifying the code. The Annexes contain further analysis and specification documents, plus copies of two papers arising from the work undertaken. These Annexes are:

Annex A:
R W Hockney,
LPM3 Benchmark Results on the Intel Paragon and iPSC/860,
Technical Note AEA/TYKB/31878/TN/6,
Culham Laboratory, July 1994.

A principal objective of the work has been to implement the body fitted PIC software on parallel computers. The benchmark code has provided the testbed for the development of the interblock message passing program units for the Paragon and iPSC. This Note summarises the parallel performance obtained for a simple 3-D electron plasma configuration.

Annex B:
W Arter,
The System of Dimensionless Units,
Technical Note AEA/TYKB/31878/TN/7,
Culham Laboratory, September 1994.

The originally proposed system of internal units described in Ref [3] has been revised. This Note outlines the new choice of units for the kernel of the simulation program PIC3D.

Annex C:
W Arter,
Dispersion and Stability Analysis for Maxwell's Equations,
Technical Note AEA/TYKB/31878/TN/8,
Culham Laboratory, September 1994.

This Note derives the stability criterion used to specify the timestep used for integration of the field equations in PIC3D.

Annex D:
N J Brealey, J W Eastwood and W Arter,
3DPIC Diagnostics,
Technical Note AEA/TYKB/31878/TN/9,
Culham Laboratory, September 1994.

This Note presents the diagnostics used by PIC3D.

Annex E:
N J Brealey,
MPICTIM User's Guide,
Technical Note AEA/TYKB/31878/TN/10,
Culham Laboratory, September 1994.

The timeseries output files (`.tsd` files) produced by PIC3D diagnostics can be examined on a UNIX Workstation using the OSF/Motif GUI tool MPICTIM. This Note describes how to use MPICTIM.

Annex F:
W Arter,
Boundary Conditions for Maxwell's Equations in General Geometry,
Technical Note AEA/TYKB/31878/TN/11,
Culham Laboratory, September 1994.

This Note contains a derivation of boundary conditions in general geometry, and a discussion of their implementation in PIC3D.

Annex G:

W Arter,
Extended Description of Inputs used to Generate Meshes,
Technical Note AEA/TYKB/31878/TN/13,
Culham Laboratory, September 1994.

This Note extends the specification give in Ref [13], and supersedes that document.

Annex H:

J W Eastwood, W Arter, N J Brealey and R W Hockney,
Body Fitted PIC Software for Microwave Device Modelling,
EUROEM, Bordeaux, France May 1994.

Annex I:

W Arter, J W Eastwood, N J Brealey and R W Hockney,
Electromagnetic Modelling in Arbitrary Geometry by PIC Methods on MIMD Computers,
pp 297-300 in 6th Joint EPS-APS Int Conf on Phys Computing PC'94
(R Gruber and M Tomassini, eds), EPS, Geneva(1994).

The original proposal was based on a bottom-up development plan, where the aim was to develop a working kernel where the geometry could only be changed by some recoding, and then to add the user functionality later. The design stage of the programme of work for Task 1 led to a substantial revision of this plan; the decision was made to reschedule the software development into a top-downwards scheme, with unit testing of groups of program units.

The top-downwards approach begins with the preprocessor's user input interface, then develops code to validate input, to display the data, and to transform the data into the form needed by the simulation kernel. This preprocessor and its interface to the kernel have proved far more difficult and time consuming than envisaged. The initial plan to use the EAGLE grid generation package [8] were abandoned after evaluating EAGLE; our assessment of that software indicated that it could be of great value in our electromagnetic code, but to exploit it would require an investment of effort that was beyond the scope of the present contract. Consequently, we have replaced EAGLE input by a less ambitious grid generation capability, but have left open the possibility of importing element nets from it at a later date.

The need for data validation and graphical display led to a number of modules being moved from the simulation kernel to the preprocessor, which in turn has required substantial reworking of the data interface. In addition, the delay in getting adequate data initialisation has hampered the development and debugging of the electromagnetic routines of the main simulation program. The design is now stable, but not complete in all its details.

The project has been a major software development effort, with more than one new subprogram being created per day, and with the same number of existing program units being adapted and integrated into the developing code structure. The subprograms have been organised by function into a number of libraries, each under SCCS configuration control to assure quality. These libraries are described below in Section 3 and in Appendix A.

2 SOFTWARE DEVELOPMENT

A history of the development of the software is given by the monthly Progress Statements [15] issued to the Contract Monitor. Inspection of those documents reveals a four part parallel development: preprocessing, simulation, diagnostics and distributed memory MIMD computer implementation. The first three of these are closely coupled by the need to develop compatible interfaces. The final item, the development of the message passing for parallel implementation, has largely been isolated by using LPM3, a 3-D extension of the 2-D benchmarking program LPM2. LPM3 has provided a test-bed for new message passing software for use on the iPSC and Paragon computers (see Annexes A and H).

The four parts of the software development correspond to the four codes

Code	Purpose
PEGGIE	preprocessing
PIC3D	simulation
MPICTIM	time series data analysis
MIMDPIC(LPM3)	3-D parallel benchmarking

MPICTIM is an interactive program which uses a Motif GUI interface. It is a general purpose time series data analysis program which was not developed under this contract, and is only being provided in an executable form for use on SUN workstations. The large number of program units shared by the other codes are split into 11 libraries, organised by function:

Library	Purpose
OLYMPUS	OLYMPUS utility library
CRONUS	OLYMPUS template library
NETBLK	block element net library
NETGLB	global element net library
EMBLK	block electromagnetic library
EMGLB	global electromagnetic library
PARBLK	block particle library
PARGLB	global particle library
GLBLIB	global data and related program units
MCDLIB	machine dependent library
DIAG	diagnostic output library

The subprograms included in the codes and libraries and a brief description of their functions are listed in Appendix A.

The main effort has been directed towards implementing those parts of the software required to initialise and execute the electromagnetic part of the calculation, although some effort (particularly in the benchmarking code) has been devoted to implementing the core of the particle integration software.

The following Sections give brief descriptions of the codes and code modules. Section 5 summarises the test datasets provided with the software.

3 DESCRIPTION OF CODES

The suite of codes stored in directory 3DPIC consists of the preprocessor, the main simulation code, the postprocessor and the parallel benchmarking code.

3.1 Preprocessing (PEGGIE)

The concept underlying the PEGGIE (Parallel Electromagnetic General Geometry Interface) approach to grid generation, boundary conditions and material property specification is that the device to be modelled is made by joining 'parts' together. An important advantage is the a 'part' might be output of another geometry package, although normally it will consist of a subroutine and the associated variables. A simple example of the specification of parts is given in Appendix B; there a section of rectangular waveguide is specified in terms of two blocks, placed side by side in the 2-direction and with conducting walls in the 1- and 3-directions, and periodic conditions in the 2-direction. Further details are given by the specification provide in Annex G.

Input to PEGGIE consists of tagged records each followed by FORTRAN NAMELIST input to assign parameters within the record, which may, for example, define the geometry of a part of block of a device. Within the limitations of the command line format PEGGIE is designed to be user friendly, ie it tolerates certain mistakes, tries to fill in gaps in input data and will flag some unusual, but not necessarily incorrect, states. There is extensive validation of input parameters, wherein grid spacings may be adjusted to make different parts fit.

The second phase of PEGGIE is concerned with generating the surface and line patches that describe block connectivity. Global co-ordinates for the part boundaries are also produced. Copious diagnostics for the developer's benefit are also generated.

For other users the main output consists of projections of the proposed device (to check that it has been specified correctly) and a data-file that serves as input to the PIC3D code. Thus PEGGIE is a general interface in the sense that control parameters and initial conditions for PIC3D may be specified.

PEGGIE uses routines from the NETGLB, NETBLK, EMBLK, GLBLIB, CRONUS and OLYMPUS libraries. There are currently 218 program units, including those from the shared libraries. Figure 1 shows the interdependence of the libraries. The links to OLYMPUS are omitted for clarity; all other program modules use the OLYMPUS module library.

3.2 Simulation (PIC3D)

The simulation code, PIC3D, is kept as small, simple and as fast as possible. Nearly all the data initialisation is performed by the preprocessor PEGGIE, and as much as possible of the data processing for diagnostics is performed by postprocessors. Each process in the parallel implementation of the main code writes separate output files which for simplicity are concatenated during postprocessing.

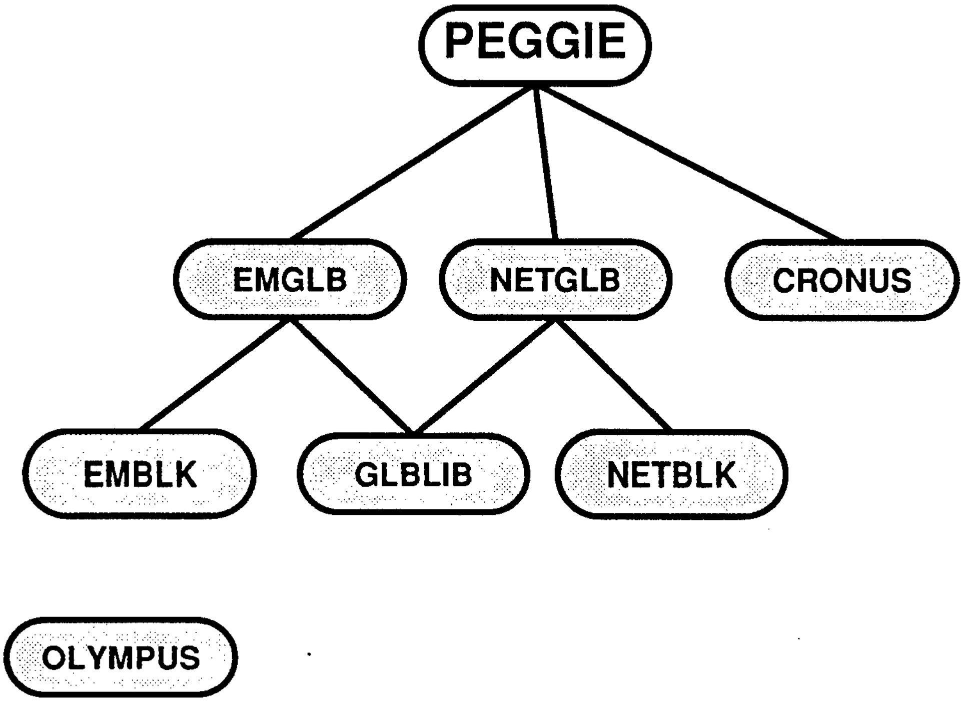

Figure 1: A schematic of the library dependencies for the preprocessor program PEGGIE

The main code uses dynamic storage allocation so that the code does not need to be recompiled for different sized problems and can use the minimum amount of storage required for each problem. Dynamic load balancing has not been implemented, but could be straightforwardly added without reworking the data structures used.

All the data control logic and a number of particle integration subprograms are already included in PIC3D, although at present these routines will work only for simple geometries. These will be developed further under the Task 2 programme of work.

The main timestep loop has been structured to include electromagnetic field integration subcycling with respect to the particle integration. Different timestepping for different blocks, although possible, has not been implemented. However, some relaxation of timestep restriction in certain cases may be possible by using the FFT filtering routines which have been incorporated into the EM solver for use with cylindrical blocks; these routines are intended for use both as noise filters and means of relaxing the Courant condition near cylindrical mesh singularities.

PIC3D uses routines from the NETGLB, NETBLK, PARGLB, PARBLK, EMGLB, EMBLK, GLBLIB, MCDLIB, CRONUS and OLYMPUS modules. It currently uses about 100 program units. Figure 2 shows the main program module and the interdependence of the support libraries. The links to OLYMPUS are omitted for clarity: all program modules depend on the OLYMPUS library.

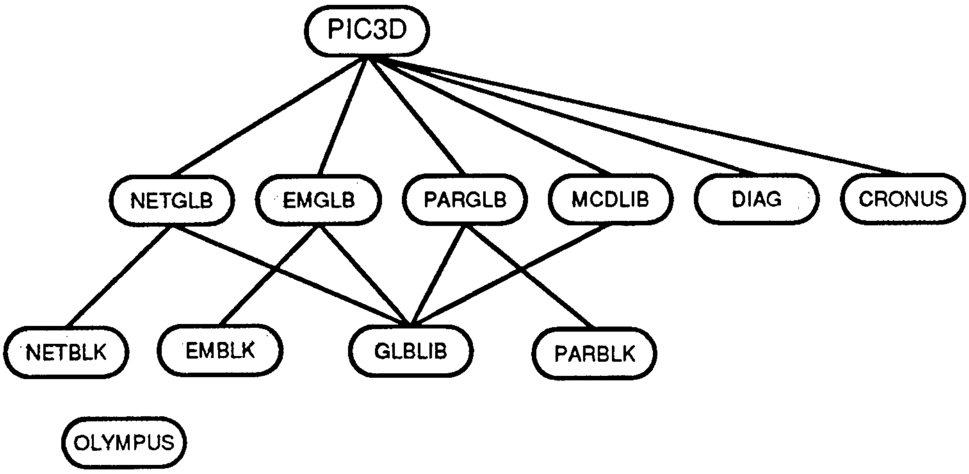

Figure 2: The main simulation code PIC3D and its support libraries. The shaded libraries are those being developed during the Task 1 phase of the project.

The PIC3D code could generate an enormous amount of graphical data. When analysing a simulation it is vital that data from the simulation is filtered to reduce the quantity of data, and data is stored in the most compact form possible.

Two classes of snapshot output are possible:

1. Line plots show the dependence of a scalar quantity on the axial position along the device. The plots are usually simple x-y line graphs.

2. Slice plots show the dependence of a scalar quantity on a slice through the device. The plots are usually contour plots or false colour plots.

The data input specification to produce these snapshot outputs and to produce datasets for MPICTIM, together with a summary of the possible outputs, is given in Annex D.

The main simulation code takes data for selected plots and saves the data in tagged unformatted files for subsequent analysis. Diagnostics in the main code may integrate over surfaces, average over time intervals or perform other processing before the data is saved. The snapshot data includes data which is averaged over a time interval as well as instantaneous values.

Particle plotting routines presently included in the libraries only work for simple cartesian test cases. The will be replaced by more robust general geometry routines in the course of the Task 2 programme of work.

3.3 Timeseries Analysis (MPICTIM)

Another output from the PIC3D is timeseries data. This data is stored in files using the same format as the 2D code TWT and 2-D MILO simulation codes developed at Culham. although the data items stored in the file may be different. The timeseries analysis tools may be used to analyse data from the

3-D code. In particular, MPICTIM, the timeseries analysis tool with a Motif GUI, may be used.

A user's guide for MPICTIM is contained in Annex E. MPICTIM was not developed under this contract, but an executable for the SUN workstation is provided to view the timeseries data generated by PIC3D test runs.

3.4 Parallel Benchmarking Code (MIMDPIC/LPM3)

LPM3 is a version of the main simulation code PIC3D with built in initialisation routines, particle integration routines, restricted geometry, and limited output. It can perform the test cases summarised in [4], and model 3-D electron plasmas in rectangular brick regions. It was developed from the earlier 2-D benchmarking code [4]. The serial implementation in directory MIMDPIC is used to generate test datasets for PIC3D and to provide cross checking data for the parallel implementation running on the Sandia Paragon machine.

The version of LPM3 on the Workstation uses the various support libraries for many of its program units. The LPM3 benchmark version installed on the Sandia Paragon XP/S 140 under the directory `~rhockne/Paragon/LPM3` was used to obtain the results from LPM3 which are presented in Annexes A, H and I.

4 DESCRIPTION OF LIBRARIES

This Section gives a description of each of the support library modules used by the suite of codes for 3-D modelling. There are currently 11 modules which are used by the preprocessor and the main code. There are a large number of program units, test units, COMMON and documentation files. The routines in each module are listed in Appendix A; further documentation is included in the `.doc` files in each of the program and library subdirectories.

The OLYMPUS and CRONUS libraries contain routines used to provide a standard software development environment [1, chap 4]. The remaining libraries are specific to the electromagnetic Particle-in-Cell software.

The three main parts of the calculation are the element net generation (NET...), the electromagnetic field calculation (EM...) and the particle integration (PAR...). Program units in each of the categories are grouped into block (...BLK) and global (...GLB) subprograms.

Block subprograms operate on data within a single curvilinear hexahedral block, and do not have access to the global connectivity data of the multiblock decomposition. NETBLK, EMBLK and PARBLK are block libraries.

Global subprograms, which handle the interconnection of the mulitblocks, use the block subprograms as primitives for data manipulation. NETGLB, EMGLB and PARGLB are global libraries. The global net data manipulated by these routines is either held in the COMMON blocks defined in module GLBLIB, or in the case of the principal field, particle and buffering arrays, in dynamically allocate memory.

The mapping of global data onto processes and from processes onto processors is machine dependent. Routines for these operations, which will differ on different architecture machines, are collected into the MCDLIB library. Each subdirectory of the 3DPIC directory (apart from MPICTIM) contains a library or program also contains a number of documentation modules, FORTRAN source and, in some cases common blocks.

4.1 CRONUS

This library contains the basic template for OLYMPUS codes [1, 9]. The library contains dummy versions of routines which are normally replaced by routines with the same name in the main module. These routines were previously in the OLYMPUS library in earlier versions of the OLYMPUS environment.

The subroutine BASIC has been enhanced so that codes fail gracefully if they can not open the files they need.

4.2 OLYMPUS

This library contains the OLYMPUS utility routines (CYCLOPS) [9]. New utility routines have been added for reading the command line (CMDLIN), concatenation of blank padded character strings (CONCAT). The *VAR and *ARRAY routines have been updated to allow variable length labels and new *OUT routines have been added for writing datasets. The UNAMES routine provides system information.

4.3 NETBLK

This module contains routines for element NETs in a BLocK. It contains routines for generating meshes and routines used to visualise meshes. The test unit TEST tests various different types of block geometries.

4.4 NETGLB

This module contains routines for global net assembly. The test unit TEST tests connecting different types of blocks together.

4.5 EMBLK

This library contains the routines for the ElectroMagnetic solver in a BLocK. There are three different versions of the Ampere equation routine:

1. AMPERE is a simple implementation which requires separate storage for $\mathbf{H}, \mathbf{j}$ and $\dot{\mathbf{d}}$. It loops through components of $\dot{\mathbf{d}}$ outside the loop which loops through nodes. It uses the standard one dimensional array addressing [3] which allows the same compact code to do 2D and 3D calculations.

2. AMPINM is an implementation which overwrites $\mathbf{H}$ with $\dot{\mathbf{d}}$, uses multidimensional arrays, and requires two planes of bordering elements as workspace.

3. AMPINV is the same as AMPINM except that it is for the outer regions where there is no particle current. In the absence of particle or other volume filling currents, it allows reduced storage by eliminating the need for current array space to be reserved for the block.

The routines GBTOH and GDTOE convert **b** to **H** and **d** to **E** respectively. The routine GORTHV sets vacuum block metrics. The routine GLUEIO transfers data to and from the glue patch buffers. Routines for embedded conductors and electromagnetic boundary conditions are contained in this module. These are at present only partially developed.

The Fast Fourier Transform routines which are used for spectral filtering are in this module.

4.6 EMGLB

This modules contains the ElectroMagnetic GLoBal routines. In general, these global routines access global data in COMMON whereas the routines in EMBLK access data via argument lists.

GETMET generates metrics, BLKIO copies data between blocks and patches and other routines deal with EM boundary conditions.

4.7 GLBLIB

This is the GLoBal data storage LIBrary. The main units in this module are the COMMON blocks for data storage. It also contains routines which initialise the COMMON blocks and read or write their contents from or to files.

4.8 MCDLIB

All routines (apart from those in the OLYMPUS library) which are MaChine Dependent are grouped into this library. At present, these are primarily the routines which exchange information between patch buffers. Special versions of these routines implement the message passing in the benchmarking program on the iPSC and Paragon computers. For use on workstations, the message passing simply becomes memory to memory copying.

4.9 PARBLK

This module contains the local particle routines. It includes routines for particle boundary conditions. The routine BEAMIN is used for injecting a prescribed beam. It uses a table to specify the beam parameters and places particles on the block surface and gives them a launch time. Support routines use the launch time to compute the particle position at the end of the time step. The routines for injected saved particles share some of the same support routines.

At present, these routines have been developed only partially for the purposes of the benchmarking tests in the iPSC and Paragon computers.

4.10 PARGLB

This module contains the global particle routines. It includes routines for loading and unloading particle buffers.

4.11 DIAG

This module contains the routines which collect and output the line, line integral, surface and volume integral diagnostics as described in Annex D.

5 TEST DATA

The four programs: PEGGIE, PIC3D, MIMDPIC and MPICTIM and the eleven associated libraries have been subjected to a number of unit test and integration tests to verify the coding. The ultimate goal of the development is to use PEGGIE (and perhaps other data preparation tools) to handle the input geometry, initial values, boundary values, material properties, numerical and computation parameters and output selections. PEGGIE validates this data (the User Input File or `.uif` file) and prepares the simulation input datasets (`.dat` file) for use by the simulator PIC3D. PIC3D outputs a number of snapshot files and timeseries data (`.tsd`) files for analysis by MPICTIM and the data analysis and visualisation tools.

Described below are some of the unit tests and integration tests provided with the software delivered to the Phillips Laboratory. Datasets appropriate for testing the source on workstations are installed in the appropriate TEST subdirectories under the directories containing the library or main code sources.

5.1 CRONUS

The unit tests of CRONUS (Appendix D) runs the default OLYMPUS skeleton program and tests a number of the OLYMPUS library routines.

5.2 OLYMPUS

The OLYMPUS library provides support for all the programs, and so is tested in all the unit and integration tests. A unit test for the machine dependent routine is included in the library and is involved by typing eg

```
make test.solaris2
```

for testing the SUN Solaris 2 implementation. Reference test outputs for SUN Solaris 1 (see Appendix E), SUN Solaris 2, Silicon Graphic Iris and HP 720 Workstations are provided.

5.3 NETBLK

A unit test program `xtest` is contained in subdirectory TEST of directory NETBLK. To execute the test program, type

```
xtest test.dat
```

An example user-program dialogue is shown in the listing of the `test.log` in Appendix F. In the test, `VPNX`, `VPNY`, `VPNZ` are the viewing position for plotting the block, and `PLOTYPE` = 1, 2 and 3 respectively select the plotting of all element edges, element edges on the block surface and block edges only.

The input dataset `test.dat`, the output file `o_test`, and a collage of the eight block plots generated (file `g_test`) are also included in Appendix F.

5.4 NETGLB

Appendix G contains a unit test which demonstrates the successful assembly of a number of blocks into a cylindrical mesh. This test demonstrates the correct logical and physical net assembly, and the mesh projection output routines. The files listed are

`mtest.log`	: a record of the interactive dialogue
`mtest.dat`	: the input dataset
`o_mtest`	: printed output
`g_mtest`	: graphical output

5.5 EMBLK

The principal testing of the electromagnetic routines is undertaken in the framework of the programs MIMPDIC and or PIC3D. However there are four unit tests included in the EMBLK directory:

1. TEST tests the FFT routines

2. TEST1 tests AMPINM and its support routines

3. TEST2 tests AMPINV and its support routines

4. TEST3 will test the field solver using cylindrical cavity modes.

Listings of output from these tests are included in Appendix H.

5.6 PEGGIE

There are 3 test cases for the PEGGIE code in the TEST directory. Case `xxx` runs with data from the input file `xxx.uif` and generates files `o_xxx`, `xxx.dat` and `g_xxx`. The cases are designed primarily to check out the geometry and normally will require some modifications to alter output and other parameters before they can be used as input to PIC3D. In particular, `mug2.dat` cannot sensibly be used with PIC3D, since the handle of the mug is only one element wide. Case `t130` models a cylindrical cavity made by assembling orthogonal annular and polar blocks. Case `uni20` generates a rectangular cavity from 8 non-orthogonal blocks. The `.uif` files are listed in Appendix B.

The `o_xxx` files are of interest solely to the developer, so only the `xxx.dat` files need checking. It is however helpful to record the graphics parameters required to generate the g_xxx files, as the reproduction of these is a simple and powerful test of code validity. Usually only the plotting window needs changing from its default values. For the cases mug2, t130 and uni20 the values used are respectively (-25, 5, -15 -15), (-25, 55,-40, 40) and (-10, 90, -30, 70). For mug2, the first parameters have also to be changed to (-0.3, 0.2, 0.7, 0, 0, 0, -1, 0, 0).

5.7 MIMDPIC

The test data sets provided with the earlier benchmarking program [4] have been updated to provide test data for the evolving 3DPIC codes. Listed below are test datasets for the current MIMDPIC program. Note that the names have been changed to user input (.uif) files, although there is a one to one correspondence with the .dat files in Ref [4].

test1.uif	:	coded exchange test
test2.uif	:	current and d array
test3.uif	:	transmission line test/constant d
test4.uif	:	transmission line test/travelling wave
test5.uif	:	3-D coded current array
test6.uif	:	3-D field test
test7.uif	:	particle mover test
test8.uif	:	particle mover test
test9.uif	:	periodic mover test
test10.uif	:	cyclotron orbit
test11.uif	:	cyclotron with E × B
test12.uif	:	current assignment check
test13.uif	:	short MITL test
test14.uif	:	longer MITL
test15.uif	:	Further E × B test
test16.uif	:	1 cavity device/no particle
test17.uif	:	5 cavity MILO/few particles
test18.uif	:	4 cavity MILO/50 steps
test19.uif	:	Symmetry bc EM transmission line
test20.uif	:	test error in G2LMAT
test21.uif	:	particle reflection bc test
test22.uif	:	uniform d start 5 cavity milo
test23.uif	:	1 block MILO test
test24.uif	:	20 block MILO test/5000 steps
test25.uif	:	20 block/finer mesh MILO 15,000 steps
test26.uif	:	04 block MILO
test31.uif	:	3-D version of test 1
test33.uif	:	3-D version of test 3
test34.uif	:	3-D version of test 4

Input dataset testnn.uif has a corresponding output file o_testnnp1, GHOST graphical output file g_testnnp1 and restart file r_testnnp1, and a PIC3D input file testnn.dat. (The suffix 'p1' is for a one processor run.

Output from m processor runs on the iPSC have suffices **pm:r** for the rth processor output from an m processor hypercube). The runs exercise the various libraries of program units, and the **testnn.dat** files provide tests of the data interfacing and of the main simulation code PIC3D.

Listings of these test runs are not included in this document because of their length. The input datasets are provided, and output can be compared to test datasets provided with the report [4].

In order to allow the development of the body fitted software to proceed in parallel with the implementation and testing on the parallel machines, a simple scalable test problem which had the same message passing properties as the full code, but did not require the general geometry metrics and boundary conditions was devised. The representative problem chosen was a multiblock implementation of a triply periodic electron plasma (see Annex A). The prototypical test case for this, **test40.uif**, is shown in Appendix J, together with the graphical output **g_test40p1**. The scatter plot shows the superposition, viewed along a principal mesh axis, of the superparticle electron positions for five steps. The plot shows the thermal spread of particles moving from their initial positions on a lattice of $2 \times 2 \times 2$ particles per element. For this particular instance, the element net comprised of a $2 \times 2 \times 2$ cube of blocks, each block containing $4 \times 4 \times 4$ elements.

5.8 PIC3D

The initial testing of the data interfacing, control structure and electromagnetic modules of PIC3D uses the **.dat** files generated by running MIMDPIC. A list of these tests is given in the previous Section. In addition, further tests using non-cartesian element nets have been performed; some success has been obtained with cylindrical nets and general element nets. Cylindrical geometry test which have produced reasonable results to date are the following:

Transmission Line Tests A transmission line test is contained in the file **tl000.dat**. The coaxial transmission line is 2 mm long and has an inner radius of 0.5 mm and an outer radius of 1 mm and the calculation is run for 0.015 ns. A 5x24x20 finite element net is used and the calculation is run for 297 steps. There is an applied field boundary at the input end and a resistive wall boundary with impedance Z_0 at the output end. A voltage is applied to the input end which is ramped up from zero over 0.0015 ns and then held constant. Figure 3 shows the voltage across the line versus time at the input and at the centre of the line. It shows the correct behaviour, namely that the signal travels along the transmission line at the speed of light and that there is no reflection at the far end. The overshoot and oscillation on the signal is due dispersion in the numerical scheme because of the rapid rise time of the input signal and the coarseness of the finite element net.

Resonant Cavity Tests A series of resonant cavity tests has been performed for a cavity which is 1 mm in radius and 2 mm long. The central region of the device consists of two 4x12x4 blocks which are joined end to end each of which is

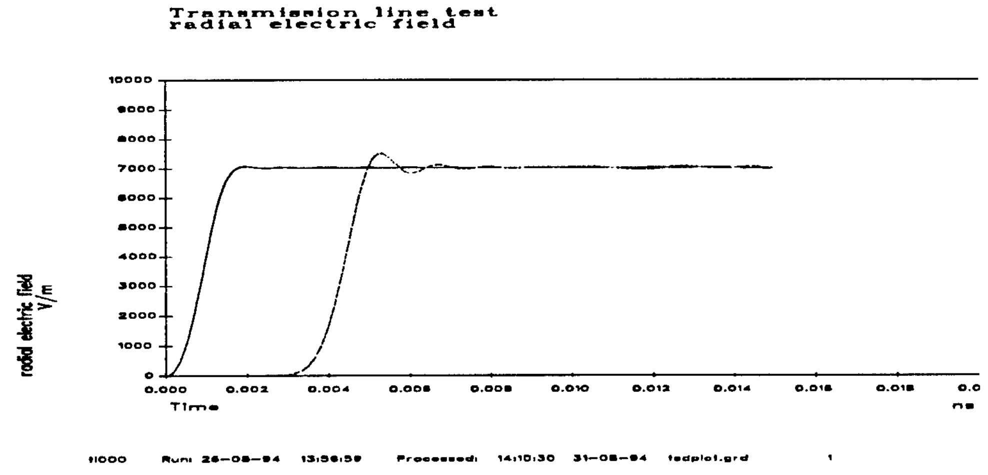

Figure 3: Transmission Line Test

surrounded by three 4x4x4 blocks. There are a total of 8 blocks and 52 patches for block connectivity and boundary conditions.

In these calculations the magnetic field is initialised to distributions for TE101, TE111, TM101 and TM111 modes and the subsequent evolution of the fields examined to see if the code is behaving correctly. The initial field is computed by evaluating the analytic form of the vector potential at the centres of edges of elements. The fields should oscillate at the frequency predicted by analytic theory. The tests test that the field solver is using the correct metrics on the axis and that the azimuthal filtering near the axis is working correctly. The datasets for these calculations `te101.dat`, `te111.dat`, `tm101.dat`, and `tm111.dat` are in the TEST subdirectory below PIC3D.

The axisymmetric cases TE101 and TM101 oscillate at a single frequencies of 196.6 GHz and 139.4 GHz respectively. The predicted frequencies are 197.7 GHz and 137.2 GHz respectively. The errors in the frequencies are approximately 0.6 % and 1.6 % respectively.

The non-axisymmetric cases TE111 and TM111 oscillate at a single frequency except for the elements near the axis. The measured frequencies are 114.9 GHz and 199.8 GHz compared with the theoretical values of 115.6 GHz and 197.7 GHz. The errors are 0.6 % and 1.1 % respectively. In the elements next to the axis the TE111 mode has a spurious oscillation at about 880 GHz which has an amplitude of about 50 % of the signal at 196.6 GHz but is only significant near the axis. The TM111 mode has a spurious oscillation at about 860 GHz which has an amplitude of about 50 % of the signal at 139.4 GHz but is only significant near the axis.

The finite element net has been refined so that there are 24 elements in the azimuthal direction in the central blocks and 8 elements in the azimuthal direction in the outer blocks. The numbers of elements in the radial and axial directions are the same as before. The TE111 case gives much better results for the refined finite element net. The frequency of the main oscillation for the

TE111 calculation is 115.5 GHz (error 0.04 %) and the spurious oscillation near the axis has an amplitude of about 7 % of the main oscillation. The TM111 calculations on the refined finite element net are not significantly different from the calculations on the coarse finite element net.

When the finite element net is refined by a factor of two in the radial and axial direction the TM111 case oscillates at 198.5 GHz (error 0.4 %). The spurious oscillation near the axis is at 1700 GHz and with an amplitude which is 85 % of the main oscillation. The discrepancies in the solutions near to the axis are larger than expected and may be due to some coding errors or to a non-optimal choice of metrics on the axis. Further work is required to resolve this issue.

Magnetostatic Field Tests The magnetostatic field tests are similar to the resonant cavity tests except that the initial field corresponds to a magnetostatic solution of Maxwell's equations. The case with a uniform magnetic field in the axial direction gives a field which remains constant and uniform to within rounding error. The cases with a uniform field in a transverse direction oscillate around the steady state value.

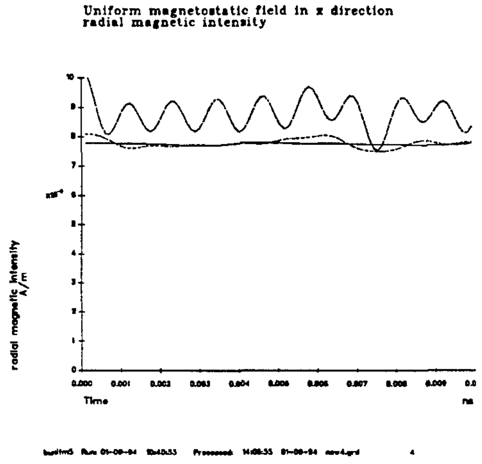

Figure 4: Magnetostatic Field Test. The plot was made from the output `.tsd` file using MPICTIM

Figure 4 shows the evolution of a the radial component of the magnetic field at three different radial locations in a calculation. The calculation uses a 8x48x8 finite element net and the radial field is plotted at the centre of elements next to the axis, two elements away from the axis and six elements away from the axis. The discrepancies in the field are greatest near that axis and have dropped to a negligible level six elements away from the axis.

General Geometry Tests General geometry tests include the case of a uniform magnetic field aligned along a rectangular cavity, meshed as the example

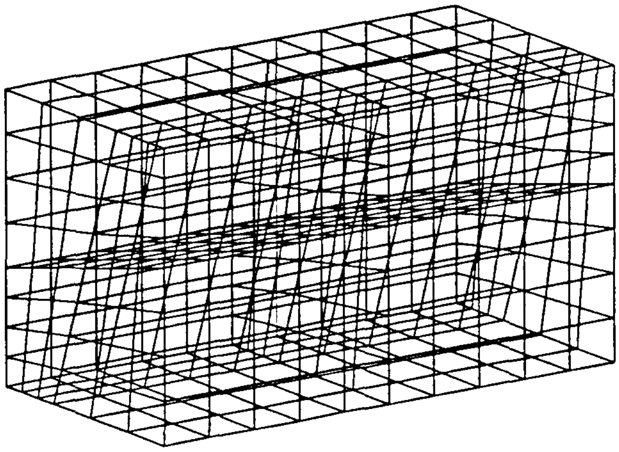

Figure 5: The rectangular cavity meshing for the general geometry test

uni20 of Section 1. Figure 5 illustrates the meshing used. The field should remain invariant, and does so to within a relative error of 5×10^{-4}. Appendix K lists the components d^i and b^i after 50 timesteps. Fields aligned in each of the other two coordinate directions have also been verified to remain approximately unchanged.

References

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APPENDICES

A List of Program Units

```
C
C     @(#)INDSUB.doc    1.6     OLYMPUS AEA     17 Mar 1994
C
C----------------------------------------------------------------------
C                            INDEX OF SUBPROGRAMS
C
C
C                                 UTILITIES.              CLASS U
C
C   MESAGE(1)     PRINT CHARACTER MESSAGE ON OUTPUT CHANNEL          U.1
C   PAGE          FETCH NEW PAGE ON OUTPUT CHANNEL                   U.2
C   BLINES(1)     INSERT BLANK LINES ON OUTPUT CHANNEL               U.3
C   RVAR(2)       PRINT NAME AND VALUE OF REAL VARIABLE              U.4
C   IVAR(2)       PRINT NAME AND VALUE OF INTEGER VARIABLE           U.5
C   AVAR(2)       PRINT NAME AND VALUE OF CHARACTER VARIABLE         U.6
C   LVAR(2)       PRINT NAME AND VALUE OF LOGICAL VARIABLE           U.7
C   RARRAY(3)     PRINT NAME AND VALUES OF REAL ARRAY                U.8
C   IARRAY(3)     PRINT NAME AND VALUES OF INTEGER ARRAY             U.9
C   AARRAY(3)     PRINT NAME AND VALUES OF CHARACTER ARRAY           U.10
C   REPTHD(3)     PRINT HEADING FOR DIAGNOSTIC REPORT                U.11
C   RUNTIM        UPDATE CPU TIME AND PRINT IT                       U.12
C   DAYTIM        PRINT DATE AND TIME                                U.13
C   RESETR(3)     RESET REAL ARRAY TO SPECIFIED VALUE                U.14
C   RESETI(3)     RESET INTEGER ARRAY TO SPECIFIED VALUE             U.15
C   RESETA(3)     RESET CHARACTER ARRAY TO SPECIFIED VALUE           U.16
C   JOBTIM        FETCH ALLOCATED JOBTIME                            U.17
C   LARRAY(3)     PRINT NAME AND VALUES OF LOGICAL ARRAY             U.18
C   RESETL(3)     RESET LOGICAL ARRAY TO SPECIFIED VALUE             U.19
C   RARAY2        PRINT DOUBLY-SUBSCRIPTED ARRAY                     U.20
C   SCALER(3)     SCALE A REAL ARRAY BY A REAL VALUE                 U.21
C   SCALEI(3)     SCALE AN INTEGER ARRAY BY AN INTEGER VALUE         U.22
C   COPYR(5)      COPY ONE REAL MATRIX INTO ANOTHER                  U.23
C   COPYI(5)      COPY ONE INTEGER MATRIX INTO ANOTHER               U.24
C   SIGNR(2)      CHANGE THE SIGN OF A REAL MATRIX                   U.25
C   SIGNI(2)      CHANGE THE SIGN OF AN INTEGER MATRIX               U.26
C   DVAR(2)       PRINT NAME AND VALUE OF DOUBLE PRECISION VARIABLE  U.28
C   DARRAY(3)     PRINT NAME AND VALUES OF DOUBLE PRECISION ARRAY    U.29
C   RESETD(3)     RESET DOUBLE PRECISION ARRAY TO VALUE              U.30
C   SCALED(3)     SCALE DOUBLE PREC. ARRAY BY DOUBLE PRECISION VALUE U.31
C   CVAR(2)       PRINT NAME AND VALUE OF COMPLEX VARIABLE           U.32
C   CARRAY(3)     PRINT NAME AND VALUES OF COMPLEX ARRAY             U.33
C   RESETC(3)     RESET COMPLEX ARRAY TO COMPLEX VALUE               U.34
C   SCALEC(3)     SCALE COMPLEX ARRAY BY COMPLEX VALUE               U.35
C   ISVAR(2)      PRINT NAME AND VALUE OF SHORT INT VARIABLE         U.36
C   ISARAY(3)     PRINT NAME AND VALUES OF SHORT INT ARRAY           U.37
C   RSETIS(3)     RESET SHORT INT ARRAY TO INTEGER VALUE             U.38
C   SCALIS(3)     SCALE SHORT INT ARRAY BY INTEGER VALUE             U.39
C   RINPUT(2)     INTERACTIVELY INPUT REAL VALUE                     U.40
C   IINPUT(2)     INTERACTIVELY INPUT INTEGER VALUE                  U.41
C   LINPUT(2)     INTERACTIVELY INPUT LOGICAL VALUE                  U.42
C   AINPUT(2)     INTERACTIVELY INPUT CHARACTER VALUE                U.43
C   RDATA(2)      INPUT REAL DATA ON CHANNEL NREAD                   U.45
C   IDATA(2)      INPUT INTEGER DATA ON CHANNEL NREAD                U.46
C   LDATA(2)      INPUT LOGICAL DATA ON CHANNEL NREAD                U.47
C   CDATA(2)      INPUT COMPLEX DATA ON CHANNEL NREAD                U.48
C   DDATA(2)      INPUT DOUBLE PRECISION VARIABLE ON CHANNEL NREAD   U.49
C   ADATA(2)      INPUT CHARACTER STRING FROM CHANNEL NREAD          U.50
C   RADATA(3)     INPUT REAL ARRAY FROM CHANNEL NREAD                U.51
C   IADATA(3)     INPUT INTEGER ARRAY FROM CHANNEL NREAD             U.52
C   LADATA(3)     INPUT LOGICAL ARRAY FROM CHANNEL NREAD             U.53
C   CADATA(3)     INPUT COMPLEX ARRAY FROM CHANNEL NREAD             U.54
C   DADATA(3)     INPUT DOUBLE PRECISION ARRAY FROM CHANNEL NREAD    U.55
C   AADATA(3)     INPUT CHARACTER ARRAY FROM CHANNEL NREAD           U.56
C   TIMER(3)      MEASURE EXECUTION TIMES                            U.57
C   TIMDAT(2)     TIME AND DATE INTERFACE ROUTINE                    U.58
C   SECOND(1)     GET CPU TIME IN SECONDS                            U.93
C   CLOCWA(1)     TIME IN HH:MM:SS FORMAT                            A.1
C   DATEWA(1)     DATE IN DD-MMM-YY FORMAT                           A.2
C   SECOWA(2)     GENERAL INTERFACE TO SYSTEM TIMING                 A.3
C   TIMRWA(1)     FIND CPU TIME USED SO FAR                          A.4
C   UNAMES(4)     INTERFACE TO POSIX UNAME ROUTINE                   A.5
C   NARGS(0)      NUMBER OF COMMAND LINE ARGUMENTS                   A.6
C   CMDLIN(2)     COMMAND LINE ARGUMENT                              A.7
C   CONCAT(3)     ADD SUFFIX TO NAME                                 A.8
C   LOUT            Write out LOGICAL data line                    4.1
C   IOUT            Write out INTEGER data line                    4.2
C   ROUT            Write out REAL data line                       4.3
C   DOUT            Write out DOUBLE PRECISION data line           4.4
```

```
C  AOUT         Write out CHARACTER data line                4.5
C  LAOUT        Write out LOGICAL array data line            4.6
C  IAOUT        Write out INTEGER array data line            4.7
C  RAOUT        Write out REAL array data line               4.8
C  DAOUT        Write out DOUBLE PRECISION array data line   4.9
C  AAOUT        Write out CHARACTER array data line          4.10
C
```

```
C
C
C---------------------------------------------------------------------
C                            INDEX OF SUBPROGRAMS
C
C
C                                 MAIN CONTROL.            CLASS 0
C
C  MASTER        FORTRAN MAIN PROGRAM                               0.0
C  BASIC         INITIALIZE BASIC CONTROL DATA                      0.1S
C  MODIFY        MODIFY BASIC DATA IF REQUIRED                      0.2
C  COTROL        CONTROL THE RUN                                    0.3
C  EXPERT(3)     MODIFY STANDARD OPERATION OF PROGRAM               0.4
C
C                                 PROLOGUE.                CLASS 1
C
C  LABRUN        LABEL THE RUN                                      1.1
C  CLEAR         CLEAR VARIABLES AND ARRAYS                         1.2
C  PRESET        SET DEFAULT VALUES                                 1.3
C  DATA          DEFINE DATA SPECIFIC TO RUN                        1.4
C  AUXVAL        SET AUXILIARY VALUES                               1.5
C  INITAL        DEFINE PHYSICAL INITIAL CONDITIONS                 1.6
C  RESUME        RESUME FROM PREVIOUS RECORD                        1.7
C  START         START OR RESTART THE RUN                           1.8
C
C                                 CALCULATION.             CLASS 2
C
C  STEPON        STEP ON THE CALCULATION                            2.1
C
C                                 OUTPUT.                  CLASS 3
C
C  OUTPUT(1)     CONTROL THE OUTPUT                                 3.1
C
C                                 EPILOGUE.                CLASS 4
C
C  TESEND        TEST FOR COMPLETION OF RUN                         4.1
C  ENDRUN        TERMINATE THE RUN                                  4.2
C
C                                 DIAGNOSTICS.             CLASS 5
C
C  REPORT(3)     CONTROL THE DIAGNOSTICS                            5.1
C  CLIST(2)      PRINT COMMON VARIABLES                             5.2
C  ARRAYS(2)     PRINT COMMON ARRAYS                                5.3
C
C                                 UTILITIES.               CLASS U
C
C  DUMCOM(3)     DUMP SELECTED COMMON BLOCKS                        U.27
C
```

```
C-----------------------------------------------------------------------
CL                          INDEX OF SUBPROGRAMS
C
C VERSION 1.00.00   JWE Culham Laboratory  Feb 1994
C
CL                            PROLOGUE            CLASS 1
C  RECTBK          set up block of rectangular elements          1.10
C  GENBLK          set up block of curvilinear elements          1.11
C  POLEDG          set up edge curves for polar mesh             1.12
C  TAPEDG          set up edge curves for taper                  1.13
C  GRDGEN          TFI grid generation from 12 bounding curves   1.14
C  IEDGE           addressing fn included in GRDGEN module       1.15
C  SETBLS          set block addressing                          1.40
C  SETOEA          set orthogonal ECOV addressing                1.41
C  MASKEA          flag data compression in ECOV storage         1.42
C  MASKHA          flag data compression in h factor storage     1.43
C  OBKPOS          compute orthogonal block node positions       1.44
C  POL2CT          convert polar triplet to cartesians           1.45
C  CROSS           compute cross product of two vectors          1.46
C
CL                            OUTPUT              CLASS 3
C  GRDPLT          plot parallel projection of grid              3.10
C  XFORMX          coordinate transformation for GRDPLT          3.11
C  BLKLOC          local node coordinates of sub-block           3.12
C  BLKPLC          convert local polar to cartesian              3.13
C  BLKGLB          convert to global coords                      3.14
C  BLKPLT          plot block                                    3.15
C  GRDGLB          compute global node coords                    3.16
C  BLASOP          print block addressing summary                3.40
C  ECOVOP          print block basis vectors                     3.41
C
```

```
C-----------------------------------------------------------------------
CL                           INDEX OF SUBPROGRAMS
C
C VERSION 1.00.00   JWE Culham Laboratory  Feb 1994
C
CL                             PROLOGUE            CLASS 1
C  SETDMP          setup tables for xpatch                          1.11
C  G2LMAT          find global to local coord transformation matr 1.14
C  SETFBL          set field block origins                          1.31
C  SETPFB          set particle field block origins                 1.32
C  ROTBK           get global ratation matrices for blocks          1.34
C  GLUETO          glue 2 blocks together                           1.35
C  GLUESP          glue surface patch to block                      1.36
C  SETBTP          set up block to patch tables                     1.37
C  GETEC           compute block basis vectors                      1.38
C  NOGEO           get block index corresponding to BG part name    1.40
C  NTPPAT          check for glue patch type                        1.41
C  KEYOP           compute integer value of patch key               1.42
C  NOFPAT          return block number corresponding to part numb 1.43
C
CL                             OUTPUT              CLASS 3
C  GLOBLT          print GLOBal Link Table                          3.2
C  MSHSUM          summary of mesh storage                          3.8
C  NETPLT          plot finite element net                          3.12
C
```

```
C-----------------------------------------------------------------------
CL                            INDEX OF SUBPROGRAMS
C
C VERSION 1.00.00   JWE Culham Laboratory  Feb 1994
C
CL                              PROLOGUE            CLASS 1
C  NILVEC            set block vector to zero                   1.20
C  SETVEC            set block vector to constant vector        1.21
C  GORTHV            set orthogonal vacuum block metrics        1.22
C  AINIT             intialise A                                1.23
C  AINITM            intialise A (3D)                           1.24
C  TECYL             compute A for cyclindrical TE mode         1.25
C  TMCYL             compute A for cyclindrical TM mode         1.26
C  TEREC             compute A for rectangular TE mode          1.27
C  TMREC             compute A for rectangular TM mode          1.28
C  ALMN              get A for lmn mode                         1.29
C  MUNIFM            compute A for uniform magnetic field       1.30
C
CL                              CALCULATION         CLASS 2
C  AMPERE            Compute displacement current               2.20
C  FARADA            Advance magnetic field one step            2.21
C  GBTOH             Compute H = Gb                             2.22
C  GDTOE             Compute E = Gd                             2.23
C  BCOPAT            apply orthogonal bc on d on patches        2.25
C  ADDVEC            add two vectors in block together          2.26
C  RETARD            Retard B by half a step                    2.27
C  BCONE             apply orthogonal bc on E on patches        2.28
C  GLUEIO            transfer data to/from gluepatch buffers    2.30
C  CPYVEC            copy block vector                          2.34
C  AVEVEC            average two vectors in block               2.35
C  BCAXI             condition on d and E on axis               2.36
C  VECFFT            perform FFT on field structures            2.50
C  SET77             FFT routine                                2.51
C  FFT77             FFT routine                                2.52
C  QPASSM            FFT routine                                2.53
C  RPASSM            FFT routine                                2.54
C  FILTR             filter spectral components                 2.55
C  FILTRM            filter spectral components (3D)            2.56
C  REPAD             reset periodic padding values              2.57
C  REPADM            reset periodic padding values (3D)         2.58
C  AMPINV            ampere equation in vacuum                  2.60
C  AMPINM            ampere equation in medium                  2.61
C  AMPMAV            ampere equation in vacumm (3D)             2.62
C  AMPMAM            ampere equation in medium (3D)             2.63
C  ADD3D             add D vector fields (3D)                   2.64
C  AMP2DV            ampere equation in vacumm (2D)             2.65
C  AMP2DM            ampere equation in medium (2D)             2.66
C
CL                              OUTPUT              CLASS 3
C  OP3VEC            print vector                               3.5
C  OPBUF             particle patch exchange buffer op          3.14
C
```

```
C-----------------------------------------------------------------------
CL                            INDEX OF SUBPROGRAMS
C
C VERSION 1.00.00   JWE Culham Laboratory  Feb 1994
C
CL                              PROLOGUE            CLASS 1
C  GETMET          compute block metrics                         1.20
C  NOPHY           return block index corresponding to BP name   1.21
C
CL                              CALCULATION         CLASS 2
C  BCSURD          apply bc on d at surfaces                     2.24
C  BCSURE          apply bc on E at surfaces                     2.27
C  BCSYM           apply symmetry bc                             2.29
C  BLKIO           copy data between block and gluepatch buffers 2.32
C
CL                              OUTPUT              CLASS 3
C  LINEGR          plot line graph of net field                  3.13
C  LINEG           plot curve for block                          3.14
C
```

PARBLK/INDSUB.doc

```
C-----------------------------------------------------------------------
CL                         INDEX OF SUBPROGRAMS
C
C VERSION 1.00.00   JWE Culham Laboratory  Feb 1994
C
CL                           PROLOGUE           CLASS 1
C  XACMAT          find acceleration transformation matrices      1.15
C
CL                           CALCULATION        CLASS 2
C  SETCUR          Initialise current arrays                      2.10
C  MOVCUR          Move particles and compute currents            2.11
C  ACCEL           Update particle momenta                        2.12
C  EMITEL          Emit electrons from cathode surfaces           2.13
C  BEAMIN          Inject electron beam                           2.14
C  PPSORT          sort particles into patch buffer               2.15
C  PCXFRM          transform coord to target block coords         2.16
C  ROTSPV          rotate and scale p and v to new x              2.17
C  QSHARE          assign charge to block mesh                    2.18
C  ASSCUR          assign current from trajectory segment         2.19
C  MERGE           merge 2 ascending lists of coordinates         2.20
C  ACCEL2          Update particle momenta for cart/polar only    2.21
C
```

```
C-----------------------------------------------------------------------
CL                         INDEX OF SUBPROGRAMS
C
C VERSION 1.00.00   JWE Culham Laboratory  Feb 1994
C
CL                           PROLOGUE            CLASS 1
C  PINIT           initialise particles                           1.13
C  SETPAR          set particle addressing                        1.14
C
CL                           CALCULATION         CLASS 2
C  PARTIO          load particles into/from exchange buffers      2.14
C  PBLINK          manage particle buffering between blocks       2.17
C  INJECT          apply particle injection bc                    2.19
C
CL                           OUTPUT              CLASS 3
C  PARTOP          particle table summary                         3.6
C  SCAPLT          particle scatter plot                          3.7
C  PARSUM          summary of particle storage                    3.9
C
```

```
C-----------------------------------------------------------------------
CL                         INDEX OF SUBPROGRAMS
C
C VERSION 1.00.00 JWE/NJB  Culham Laboratory  Feb 1994
C
CL                           CONTROL             CLASS 0
C  RECORD          read and write restart data                     0.5
C
CL                           PROLOGUE            CLASS 1
C  CLEAR           set common variables and arrays                 1.2
C  PRESET          Set default values                              1.3
C  RESUME          resume from previous run                        1.7
C  MOUDAT          output IV from MIMDPIC for PIC3D                1.9
C  ADRDIM          set addressing and dimensioning parameters      1.39
C  SETADP          set addressing parameters                       1.44
C  SETDIP          set dimensioning parameters                     1.45
C  SETFDP          set fixed dimensioning parameters               1.46
C  SETPCN          set physical constants                          1.47
C  DATA            Input data specific to run                      1.4R
C
CL                           OUTPUT              CLASS 3
C  OUTDAT          write out data file                             3.1
C  FRAMEL          label and advance frame                         3.10
C  GHINIT          initialise graphical output                     3.11
C
```

```
C-----------------------------------------------------------------------
CL                         INDEX OF SUBPROGRAMS
C
C VERSION 1.00.00   JWE Culham Laboratory  Feb 1994
C
CL                           PROLOGUE            CLASS 1
C  SETDMP          setup tables for xpatch                         1.11
C  NODASG          assign processes to processors(nodes)           1.12
C
CL                           CALCULATION         CLASS 2
C  XPATCH          exchange gluepatch buffers                      2.31
C  XPART           exchange particle coordinates                   2.33
C
CL                           OUTPUT              CLASS 3
C  PATOP           patch diagnostic output                         3.3
C
CL                           UTILITIES           CLASS P
C  CSEND           dummies for Intel routines                      P.1
C
```

```
C-----------------------------------------------------------------------
CL                         INDEX OF SUBPROGRAMS
C
C VERSION 1   N J Brealey     AEA Technology     June 1994
C
CL                           CALCULATION         CLASS 2
C  DIAINT          initialise diagnostics                         2.18
C  DIACOL          diagnostic collection                          2.19
C  DIAOUT          output diagnostic data                         2.20
C  DIAFIN          finish diagnostic output                       2.21
C
CL                           OUTPUT              CLASS 3
C  TSDHED          read or write TSD header                       3.1
C  TSDENT          read or write TSD entry                        3.2
C  TSDSET          setup TSD output                               3.3
C  TSFLAG          set flags for time set                         3.4
C  GFILNM          get file name                                  3.5
C  SETDWS          set diagnostic workspace origins               3.6
C  GRLSET          setup GRL output                               3.7
C  TSDOUT          output TSD data                                3.8
C  GRLOUT          output GRL data                                3.9
C  GRLPLT          plot GRL data                                  3.10
C  LPLOT           plot a set of lines                            3.11
C
CL                           EPILOGUE            CLASS 4
C  IEDL            line integral of E                             4.1
C  IEDLM           line integral of E (3D)                        4.2
C  IHDL            line integral of H                             4.3
C  IHDLM           line integral of H (3D)                        4.4
C  IDDS            surface integral of D                          4.5
C  IDDSM           line integral of E (3D)                        4.6
C  IBDS            surface integral of D                          4.7
C  IBDSM           surface integral of D (3D)                     4.8
C  IBHV            volume integral of B.H                         4.9
C  IBHVM           volume integral of B.H (3D)                    4.10
C  IEDV            volume integral of E.D                         4.11
C  IEDVM           volume integral of E.D (3D)                    4.12
C  ARCLN           compute arc lengths                            4.13
C  ARCLNM          compute arc lengths (3D)                       4.14
C  E123            physical component of E                        4.15
C  E123M           physical component of E (3D)                   4.16
C  H123            physical component of H                        4.17
C  H123M           physical component of H (3D)                   4.18
C  SUCLR           clear SU workspace                             4.19
C  SUSCL           scale SU workspace                             4.20
C  SUADD           add SU workspace                               4.21
C  SUMAX           max and min of SU workspace                    4.22
C
```

```
C-----------------------------------------------------------------------
CL                            INDEX OF SUBPROGRAMS
C
C VERSION 1.00.00 WA Culham Laboratory  Mar 1994
C
CL                              CONTROL              CLASS 0
C  RECORD           read and write restart data                   0.5
C
CL                              PROLOGUE             CLASS 1
C  LABRUN           Label the run                                 1.1
C  CLEAR            set common variables and arrays               1.2
C  PRESET           Set default values                            1.3
C  AUXVAL           SET AUXILLIARY VALUES                         1.5
C  START            read records                                  1.8
C  RDFMT1           read tagged format 1                          1.11
C  RDFMT2           read tagged format 2                          1.12
C  RDFMT3           read tagged format 3                          1.13
C  RDFMT4           read tagged format 4                          1.14
C  RDFMT5           read tagged format 5                          1.15
C  RDFMT6           read tagged format 6                          1.16
C  RDFMT7           read tagged format 7                          1.17
C  PREORD           cube geometry ordering                        1.31
C  PRECLA           set up class list                             1.32
C  PREQUD           quadrature for metric                         1.33
C  GETECW           compute block basis vectors                   1.39
C  SCALEV           scale covariant vectors in block              1.40
C  DATA             Input data specific to run                    1.4R
C
CL                              CALCULATION          CLASS 2
C  STEPON           control computation                           2.1
C  VCLAS            validate classes                              2.3
C  SEXION           sectional information                         2.4
C  INCODE           input conversion and sorting                  2.5
C  VCOVER           check all blocks covered                      2.6
C  VORI             check relative orientations                   2.7
C  VCONN            check block connectivity                      2.8
C  CPATBK           surface patch - block tables                  2.12
C  CLIPAT           line patches                                  2.13
C  PATEDG           sort patches by edge                          2.14
C  PTRAIL           patch trails                                  2.15
C  PEGGY            peg into main line notation                   2.16
C  CGLOBV           global positioning variables                  2.17
C  CGPHYA           global physical attribute table               2.18
C  GETSP            compute boundary condition attributes         2.19
C  NAMLIS           namelist handling                             2.20
C  NAMINP           real namelist input                           2.21
C  OXCONV           CONVERT OX NOTATION TO INTERNAL REPN          2.22
C  LOCPOS           local positions                               2.23
C  XYZROT           block vectors and rotation matrices           2.24
C  CROTBK           ultimate global system                        2.25
C  P2LMAT           provisional global to local coord rotation mat 2.26
C  GETCDT           calculate timestep * (speed of light)         2.27
C  CALCDT           calculate timestep * c  for block             2.28
C  GETSCA           scaling to dimensionless variables            2.29
C
CL                              OUTPUT               CLASS 3
C  OUTPUT           control output                                3.1
C  DIAGN            Diagnostic output                             3.3
C
CL                              EPILOGUE             CLASS 4
C  TESEND           test for completion of run                    4.1
C  ENDRUN           terminate the run                             4.2
C
```

```
C-----------------------------------------------------------------------
CL                      INDEX OF SUBPROGRAMS
C
C VERSION 1.00.00   N J Brealey     AEA Technology     Feb 1994
C
CL                        CONTROL            CLASS 0
C  COTROL          Control the run                           0.3
C
CL                        PROLOGUE           CLASS 1
C  LABRUN          label the run                             1.1
C  AUXVAL          set auxilary values                       1.5
C  INITAL          setup physical initial conditions         1.6
C  RESTOR          restore device description                1.9
C  STRAGE          allocate storage                          1.10
C  MIMDAT          read data for MIMDPIC commons             1.11
C  BINIT           compute initial B                         1.12
C  MINDAT          I.V. input data from MIMDPIC              1.13
C
CL                        CALCULATION        CLASS 2
C  STEPON          advance calculation one step              2.1
C  MOVE1           inject and particle move 1                2.2
C  DFILTR          filter Ddot                               2.3
C  MOVE2           particle move 2                           2.4
C  CFILTR          filter current                            2.5
C  CSPLIT          split current for subcycling              2.6
C  DDOT            compute ddot                              2.7
C  BUFUNL          unload glue patch buffers                 2.8
C  INJECT          inject particles                          2.9
C  DTOE            convert D to E in blocks                  2.10
C  BTOH            convert B to H                            2.11
C  ADVB            advance B                                 2.12
C  RETB            retard B half a step                      2.13
C  NEWP            update momenta                            2.14
C  EBEXT           add external field                        2.15
C  DDOT2           alternative version od DDOT/BTOH          2.18
C
CL                        OUTPUT             CLASS 3
C  OUTPUT          control the output                        3.1
C  MIMOUT          output for MIMDPIC                        3.2
C  RESTRT          write to disc                             3.4
C
CL                        EPILOGUE           CLASS 4
C  TESEND          test for completion of run                4.2
C
```

```
C-----------------------------------------------------------------------
CL                         INDEX OF SUBPROGRAMS
C
C VERSION 1.00.00   JWE Culham Laboratory  Feb 1994
C
CL                           CONTROL             CLASS 0
C  BASIC           Version without input file read for MIMD       0.1
C  MODIFY          Version to create separate ouput files         0.2
C  COTROL          Control the run                                0.3
C  EXPERT          test data dump version                         0.4
C  RECORD          Read and write restart coordinates             0.5
C
CL                           PROLOGUE            CLASS 1
C  LABRUN          Label the run                                  1.1
C  CLEAR           Clear common arrays and variables              1.2
C  PRESET          Set default values, not MYPRES etc             1.3
C  DATOLD          old version of data cls4r                      1.4
C  AUXVAL          Compute auxillary values                       1.5
C  INITAL          Define geometrical and physical IV             1.6
C  RESUME          resume from previous run                       1.7
C  START           start the calculation                          1.8
C  MOUDAT          output IV for PIC3D                            1.9
C
CL                           CALCULATION         CLASS 2
C  STEPON          step on the calculation                        2.1
C
CL                           OUTPUT              CLASS 3
C  OUTPUT          Control the output                             3.1
C
CL                           EPILOGUE            CLASS 4
C  TESEND          Test for completion of run                     4.1
C  ENDRUN          Terminate the run                              4.2
C
CL                           DIAGNOSTICS         CLASS 5
C  CLIST           Dump common variables                          5.2
C  ARRAYS          Dump common arrays                             5.3
C
CL                           UTILITIES           CLASS X
C  GLBCLR          clear global array quantities                  X.1
C  RECTBK          set up rectangular brick blocktype             X.1
C  GLBCLI          Dump common variables                          X.2
C  GRDPLT          plot parallel projection of block grid         X.2
C  GLBARR          Dump common arrays                             X.3
C  NETPLT          plot finite element net                        X.3
C
```

B Sample preprocessor input dataset

```
o_pbc1
'NLRES  L  False for NEWRUN,True for RESET' F
pbc1
Periodic section of rectangular waveguide
using two cartesian blocks
conducting walls in 1 and 3 directions
periodic bc in 2 direction
'CHLAB5   A  **Label available to programmer          1.1 ' /
'NDIARY   I  **Channel for diary                      1.2 ' /
'NIN      I  **Current input channel                  1.2 ' /
'NLEDGE   I  **Channel for restart records            1.2 ' /
'NONLIN   I  **Channel for input-output               1.2 ' /
'NOUT     I  **Current output channel                 1.2 ' /
'NPRINT   I  **Channel for printed output             1.2 ' /
'NPUNCH   I  **Channel for card output (or equivalent)   1.2 ' /
'NREC     I  **Current record number                  1.2 ' /
'NRUN     I  **Maximum number of steps                1.2 ' /
'NADUMP   IA **Codes for array dumps                  1.9 ' /
'NPDUMP   IA **Codes for dumping points               1.9 ' /
'NVDUMP   IA **Codes for dumping arrays               1.9 ' /
'NLCHED   L  **.TRUE. if class 0 report-head required    1.9 ' /
'NLHEAD   LA **.TRUE. if class 1-9 report-heads required 1.9 ' /
'NLOMT1   LA **Class 1 subprogram selector            1.9 ' /
'NLOMT2   LA **Class 2 subprogram selector            1.9 ' /
'NLOMT3   LA **Class 3 subprogram selector            1.9 ' /
'NLREPT   L  **.TRUE. if report required              1.9 ' /
BL block1 cube uniform1
BL block2 cube uniform1
BG cube regular_cubic_lattice -6  -10 -16
&CUBREG RXMAX=1.,RYMAX=2.,RZMAX=3./
BP uniform1 uniform
&UNIFRM EPSR=1.,RMUR=1./
PP pcond pcond
PA pcond sameas pcond
BC block1
W=pcond
S=block1:N
N=block1:S
E=block2:W
U=pcond
Down =pcond
EN
BC block2
W=block1:E
S=block2:N
N=block2:S
E=pcond
U=pcond
D=pcond
EN
OR block1 block2
```

C PIC3D input dataset template

```
o_newrun
'NLRES  L  False for NEWRUN,True for RESET' /
exp00001  8 character label for run sequence
CHLAB1    replace these four lines
CHLAB2    by run labelling information
CHLAB3    which will appear at the start
CHLAB4    of the NOUT channel output
'CHLAB5   A  **Label available to programmer         1.1 ' /
'NDIARY   I  **Channel for diary                     1.2 ' /
'NIN      I  **Current input channel                 1.2 ' /
'NLEDGE   I  **Channel for restart records           1.2 ' /
'NONLIN   I  **Channel for input-output              1.2 ' /
'NOUT     I  **Current output channel                1.2 ' /
'NPRINT   I  **Channel for printed output            1.2 ' /
'NPUNCH   I  **Channel for card output (or equivalent)  1.2 ' /
'NREC     I  **Current record number                 1.2 ' /
'NRUN     I  **Maximum number of steps               1.2 ' /
'NADUMP   IA **Codes for array dumps                 1.9 ' /
'NPDUMP   IA **Codes for dumping points              1.9 ' /
'NVDUMP   IA **Codes for dumping arrays              1.9 ' /
'NLCHED   L  **.TRUE. if class 0 report-head required   1.9 ' /
'NLHEAD   LA **.TRUE. if class 1-9 report-heads required 1.9 ' /
'NLOMT1   LA **Class 1 subprogram selector           1.9 ' /
'NLOMT2   LA **Class 2 subprogram selector           1.9 ' /
'NLOMT3   LA **Class 3 subprogram selector           1.9 ' /
'NLREPT   L  **.TRUE. if report required             1.9 ' /
'COUR     R  *max courant number                     3.1 ' /
'DT       R  *Timestep                               3.1 ' /
'SCALE    RA *scale to SI factors                    3.1 ' /
'NSUBS    I  *number of em steps per particle step   3.1 ' /
'ROTG2L   RA *block global to local coord rotation   4.1 ' /
'XYZBLK   RA *block corner global coords             4.1 ' /
'MBKPAT   IA *block to patch hoc table               4.1 ' /
'MBKTYP   IA *block to blocktype pointer             4.1 ' /
'MEMBCA   IA *EM patch to BC attribute table         4.1 ' /
'MPABCA   IA *particle patch to BC attribute table   4.1 ' /
'MPATBK   IA *patch to block pointer                 4.1 ' /
'MPATO    IA *location code of patch origin on blocks   4.1 ' /
'MPATX    IA *location code of patch extreme on blocks  4.1 ' /
'MPATYP   IA *patch type index                       4.1 ' /
'NBLOCK   I  *number of blocks                       4.1 ' /
'NPATCH   I  *number of patches                      4.1 ' /
'NXTPAT   IA *link to next patch on block            4.1 ' /
'LBLAS    IA *list of block addressing structures    4.2 ' /
'LECOVA   IA *list of ECOV Addressing                4.2 ' /
'LGBHAD   IA *list of G addressing for H=G b         4.2 ' /
'LGDEAD   IA *list of G addressing for E=G d         4.2 ' /
'LOAGBH   IA *location of GBH addr. in LGBHAD        4.2 ' /
'LOAGDE   IA *location of GDE addr. in LGDEAD        4.2 ' /
'LOBLAS   IA *location of origins of block addresses    4.2 ' /
'LOECOA   IA *location of addressing in LECOVA       4.2 ' /
'LOECOV   IA *location of origins in ECOV array      4.2 ' /
'LORGBH   IA *location of origins of GBH in G array  4.2 ' /
'LORGDE   IA *location of origins of GDE in G array  4.2 ' /
'MBPROP   IA *block properties                       4.2 ' /
'NBTYPE   I  *number of block types                  4.2 ' /
'SPATR    RA *array of particle species attributes   4.3 ' /
'LOCOOR   IA **Location of Origins of COORdinates    4.3 ' /
'LOPARA   IA *Location of Origin of blocks in LPARAS    4.3 ' /
'LPARAS   IA *List of addressing for coordinates     4.3 ' /
'NSPEC    I  *number of particle species             4.3 ' /
'MBKPES   IA *block to processor pointer             4.4 ' /
'MPRBLK   IA *process to block hoc table             4.4 ' /
'MSTAT    IA *Status of message array                4.4 ' /
'NXTBLK   IA *next block in processor                4.4 ' /
'MDBCA    I  *Dimension of bc attribute arrays       4.6 ' /
'MDIOB    I  **Dimension of IO Buffer arrays         4.6 ' /
'MDPART   I  **Dimension of PARTicle coordinate arrays  4.6 ' /
'MECDIM   I  *ECov array DIMension                   4.6 ' /
'MGDIM    I  *Metric G array DIMension               4.6 ' /
'NDSPS    IA **numbers of domain sets in each plot set  5.0 ' /
'NFSPS    IA **numbers of field sets in each plot set   5.0 ' /
'NPS      I  **number of plot sets                   5.0 ' /
'NTSPS    IA **numbers of time sets in each plot set    5.0 ' /
'CFMTPS   AA **file format for each plot set         5.1 ' /
'MFLFS    IA **number of fields in each field set    5.2 ' /
'NFLFS    IA **numbers of fields in each field set   5.2 ' /
'NFS      I  **number of field sets                  5.2 ' /
```

```
'NPSFS    IA **plot sets of each field set          5.2 ' /
'MDODS    IA **number of domains in each domain set  5.3 ' /
'NDODS    IA **numbers of domains in each domain set 5.3 ' /
'NDS      I  **number of domain sets                5.3 ' /
'NPSDS    IA **plot sets of each domain set         5.3 ' /
'TIMETS   RA **start, stop, output, average times, time z5.4 ' /
'NPSTS    IA **plot sets of each time set           5.4 ' /
'NSTPTS   IA **start, stop, output, average steps, step z5.4 ' /
'NTS      I  **number of time sets                  5.4 ' /
'CNLTIM   AA **long names of time                   5.5 ' /
'CNSTIM   AA **short names of time                  5.5 ' /
'CNUFRQ   AA **units of frequency                   5.5 ' /
'CNURAT   AA **units of rate of change              5.5 ' /
'CNUTIM   AA **units of time                        5.5 ' /
'SCLDO    RA **zero and unit of arc length          5.6 ' /
'SLIMDO   RA **domain arc length limits             5.6 ' /
'MSUDO    IA **number of subdomains in each domain  5.6 ' /
'NCOLDO   IA **domain colours                       5.6 ' /
'NDO      I  **number of domains                    5.6 ' /
'NDSDO    IA **domain sets of each domain           5.6 ' /
'NSUDO    IA **numbers of subdomains in each domain 5.6 ' /
'CNLDO    AA **long names of domains                5.7 ' /
'CNSDO    AA **short names of domains               5.7 ' /
'FLIMFL   RA **field limits                         5.8 ' /
'SCLFL    RA **zero and unit of field               5.8 ' /
'NCOLFL   IA **field colours                        5.8 ' /
'NFL      I  **number of fields                     5.8 ' /
'NFSFL    IA **field sets of each field             5.8 ' /
'CFLSPC   AA **field specification                  5.9 ' /
'CNLFL    AA **long names of fields                 5.9 ' /
'CNSFL    AA **short names of fields                5.9 ' /
'CNUFL    AA **units of fields                      5.9 ' /
'NPSU     IA **primary subdomain of subdomain       6.0 ' /
'NSU      I  **number of subdomains                 6.0 ' /
'NSUBLK   IA **subdomain block number               6.0 ' /
'NSUD     IA **subdomain directions                 6.0 ' /
'NSUDOM   IA **subdomain domain number              6.0 ' /
'NSUDS    IA **subdomain domain set number          6.0 ' /
'NSUFS    IA **subdomain field set number           6.0 ' /
'NSUO     IA **subdomain o element                  6.0 ' /
'NSUPS    IA **subdomain plot set number            6.0 ' /
'NSUTS    IA **subdomain time set number            6.0 ' /
'NSUX     IA **subdomain x element                  6.0 ' /
'NXTPSU   IA **next primary subdomain               6.0 ' /
'AMODE    RA *box size for modes                    6.1 ' /
'BUNI     RA *uniform initial B                     6.1 ' /
'CMODE    RA *mode amplitudes                       6.1 ' /
'NBEXT    I  *use initial B as external B           6.1 ' /
'NINIT    I  *initial field type                    6.1 ' /
'NMODE    IA *mode numbers                          6.1 ' /
```

D CRONUS unit test data

```
o_test
'NLRES  L  False for NEWRUN,True for RESET' /
```

```
        UNIX - OLYMPUS ENVIRONMENT
        UNIX Version 1S        Dec 1989   CULHAM
        James W EASTWOOD and Wayne ARTER
        0.1 BASIC CONTROL DATA SET
 NLRES    =              F (             F ) : NLRES   L  False for NEWRUN,True for RESET
Input file = test.dat
        0.2 STANDARD DATA ACCEPTED
     13:47:02  16-Sep-94
        0.3 ENTER RUN CONTROL
       1.1 LABEL THE RUN
       1.2 CLEAR VARIABLES AND ARRAYS
       1.3 SET DEFAULT VALUES
       1.4 DEFINE DATA SPECIFIC TO RUN
       1.5 SET AUXILIARY VALUES
       1.6 DEFINE PHYSICAL INITIAL CONDITIONS
       1.8 START OR RESTART THE RUN
       3.1 CONTROL THE OUTPUT
    CALL      =           1
       INITIAL OUTPUT (1)
       2.1 STEP ON THE CALCULATION
       3.1 CONTROL THE OUTPUT
    CALL      =           2
       PERIODIC OUTPUT (2)
       4.1 TEST FOR COMPLETION OF RUN
       3.1 CONTROL THE OUTPUT
    CALL      =           3
       FINAL OUTPUT (3)
       4.2 TERMINATE THE RUN


     13:47:02  16-Sep-94
     Elapse time so far =  3.0000E-02 secs:-
     user =  5.0000E-02 secs
     system =  3.9000E-01 secs
1
```

E OLYMPUS unit test data

```
OS Implementation: SunOS
Network node:      rfesunh
OS release:        5.2
OS version:        Generic_100999-51
Hardware name:     sun4c

Time: 14:36:35
Date: 19-Sep-94

Number of command line arguments:   3
Argument   0: ./olytst
Argument   1: one
Argument   2: two
Argument   3: three

Checking CONCAT function:
SunOS5.2

 Run time:        3.47000
 User time:       3.12000
 System time:    0.350000
 Total time:      3.47000
```

F NETBLK unit test data

```
rfesunh% xtest test.dat
   VPNX        = -1.0000E+00
/
   VPNY        = -3.0000E-01
/
   VPNZ        =  7.0000E-01
/

  PLOTYPE    =            2
/
another projection? y/n
n
   VPNX        = -1.0000E+00
/
   VPNY        = -3.0000E-01
/
   VPNZ        =  7.0000E-01
/

  PLOTYPE    =            2
/
another projection? y/n
n
   VPNX        = -1.0000E+00
/
   VPNY        = -3.0000E-01
/
   VPNZ        =  7.0000E-01
/

  PLOTYPE    =            2
/
another projection? y/n
n
   VPNX        = -1.0000E+00
/
   VPNY        = -3.0000E-01
/
   VPNZ        =  7.0000E-01
/

  PLOTYPE    =            2
/
another projection? y/n
n
   VPNX        = -1.0000E+00
/
   VPNY        = -3.0000E-01
/
   VPNZ        =  7.0000E-01
/

  PLOTYPE    =            2
/
another projection? y/n
n
   VPNX        = -1.0000E+00
/
   VPNY        = -3.0000E-01
/
   VPNZ        =  7.0000E-01
/

  PLOTYPE    =            2
/
another projection? y/n
n
   VPNX        = -1.0000E+00
/
   VPNY        = -3.0000E-01
/
   VPNZ        =  7.0000E-01
/

  PLOTYPE    =            2
/
another projection? y/n
n
   VPNX        = -1.0000E+00
/
   VPNY        = -3.0000E-01
/
   VPNZ        =  7.0000E-01
/

  PLOTYPE    =            2
/
another projection? y/n
n
```

```
o_test
'NLRES  L  False for NEWRUN,True for RESET' /
test01
NETBLK unit test data
To run, type xtest test.dat
In the interactive dialogue,
accept defaults to get standard test OP.
'CHLAB5   A  **Label available to programmer           1.1 ' /
'NDIARY   I  **Channel for diary                       1.2 ' /
'NIN      I  **Current input channel                   1.2 ' /
'NLEDGE   I  **Channel for restart records             1.2 ' /
'NONLIN   I  **Channel for input-output                1.2 ' /
'NOUT     I  **Current output channel                  1.2 ' /
'NPRINT   I  **Channel for printed output              1.2 ' /
'NPUNCH   I  **Channel for card output (or equivalent) 1.2 ' /
'NREC     I  **Current record number                   1.2 ' /
'NRUN     I  **Maximum number of steps                 1.2 ' /
'NADUMP   IA **Codes for array dumps                   1.9 ' /
'NPDUMP   IA **Codes for dumping points                1.9 ' /
'NVDUMP   IA **Codes for dumping arrays                1.9 ' /
'NLCHED   L  **.TRUE. if class 0 report-head required  1.9 ' /
'NLHEAD   LA **.TRUE. if class 1-9 report-heads required 1.9 ' /
'NLOMT1   LA **Class 1 subprogram selector             1.9 ' /
'NLOMT2   LA **Class 2 subprogram selector             1.9 ' /
'NLOMT3   LA **Class 3 subprogram selector             1.9 ' /
'NLREPT   L  **.TRUE. if report required               1.9 ' /
```

```
       UNIX - OLYMPUS ENVIRONMENT
       UNIX Version 1S          Dec 1989   CULHAM
       James W EASTWOOD and Wayne ARTER
       0.1 BASIC CONTROL DATA SET
 NLRES    =             F (            F ) : NLRES  L  False for NEWRUN,True fo
r RESET
Input file = test.dat

       0.2 STANDARD DATA ACCEPTED
    10:37:57  16-Sep-94




                                                     P R O G R A M   T E S T
                                                     **********************



           test01

           NETBLK unit test data

           To run, type xtest test.dat

           In the interactive dialogue,

           accept defaults to get standard test OP.



Polar with local polar coords
============================

   E-SPACE =          12
 j,ecov(j)    1  0.000E+00
 j,ecov(j)    2  2.500E-01
 j,ecov(j)    3  2.618E-01
 j,ecov(j)    4  3.333E-01
 j,ecov(j)    5  1.000E+00
 j,ecov(j)    6  5.000E-01
 j,ecov(j)    7  7.500E-01
 j,ecov(j)    8  1.000E+00
 j,ecov(j)    9  1.250E+00
 j,ecov(j)   10  1.500E+00
 j,ecov(j)   11  0.000E+00
 j,ecov(j)   12  0.000E+00

  BLOCK ADDRESSING SUMMARY, BLOCK    1
```

```
  ===================================

     Coordinate  Number of    Mesh     Origin
       Index      Elements  Increment
     ==========  =========  =========  ======


         1           4          5         1
         2           4         25       101
         3           3        100       201

  Dimensionality =  3

 Cylindrical polar local reference coordinates

         Index      Increment 1 Increment 2 Increment 3    Origin
         =====      =========== =========== ===========    ======


           1            0           0           0           2
           2            0           0           0           1
           3            0           0           0           1
           4            0           0           0           1
           5            0           0           0           3
           6            0           0           0           1
           7            0           0           0           1
           8            0           0           0           1
           9            0           0           0           4
          10            0           0           0           5
          11            1           0           0           6
          12            0           0           0           5
   VPNX        = -1.0000E+00
   VPNY        = -3.0000E-01
   VPNZ        =  7.0000E-01

  PLOTYPE    =            2


 Polar with local polar axis
 ==========================

    E-SPACE =          12


  BLOCK ADDRESSING SUMMARY, BLOCK    1
  ===================================

     Coordinate  Number of    Mesh     Origin
       Index      Elements  Increment
     ==========  =========  =========  ======


         1           4          5         1
         2          12         65       261
         3           3        260       521
 Dimensionality =  3

Cylindrical polar local reference coordinates

        Index      Increment 1 Increment 2 Increment 3    Origin
        =====      =========== =========== ===========    ======


            1          0           0           0           2
            2          0           0           0           1
            3          0           0           0           1
            4          0           0           0           1
            5          0           0           0           3
            6          0           0           0           1
            7          0           0           0           1
            8          0           0           0           1
            9          0           0           0           4
           10          0           0           0           5
           11          1           0           0           6
           12          0           0           0           5
  VPNX        = -1.0000E+00
  VPNY        = -3.0000E-01
  VPNZ        =  7.0000E-01

 PLOTYPE     =           2
MASKHA     0     0     4    12     3  3.687E-01  5.259E-01
MASKHA     1     0     4    12     3  3.687E-01  5.259E-01
MASKHA     2     0     4    12     3  3.687E-01  5.259E-01
MASKHA     3     0     4    12     3  3.687E-01  5.259E-01
MASKHA     4     0     4    12     3  3.687E-01  5.259E-01
MASKHA     5     0     4    12     3  3.687E-01  5.259E-01
MASKHA     6     0     4    12     3  3.687E-01  5.259E-01
MASKHA     7     0     4    12     3  3.687E-01  5.259E-01
MASKHA     8     0     4    12     3  3.687E-01  5.259E-01
MASKHA     9     0     4    12     3  3.687E-01  5.259E-01
MASKHA    10     0     4    12     3  3.687E-01  5.259E-01
MASKHA    11     0     4    12     3  3.687E-01  5.259E-01
MASKHA    12     0     4    12     3  3.687E-01  5.259E-01
MASKHA     0     1     4    12     3  3.687E-01  5.259E-01
MASKHA     1     1     4    12     3  3.687E-01  5.259E-01
MASKHA     2     1     4    12     3  3.687E-01  5.259E-01
MASKHA     3     1     4    12     3  3.687E-01  5.259E-01
MASKHA     4     1     4    12     3  3.687E-01  5.259E-01
MASKHA     5     1     4    12     3  3.687E-01  5.259E-01
MASKHA     6     1     4    12     3  3.687E-01  5.259E-01
MASKHA     7     1     4    12     3  3.687E-01  5.259E-01
MASKHA     8     1     4    12     3  3.687E-01  5.259E-01
MASKHA     9     1     4    12     3  3.687E-01  5.259E-01
MASKHA    10     1     4    12     3  3.687E-01  5.259E-01
MASKHA    11     1     4    12     3  3.687E-01  5.259E-01
MASKHA    12     1     4    12     3  3.687E-01  5.259E-01
MASKHA     0     2     4    12     3  3.687E-01  5.259E-01
MASKHA     1     2     4    12     3  3.687E-01  5.259E-01
MASKHA     2     2     4    12     3  3.687E-01  5.259E-01
MASKHA     3     2     4    12     3  3.687E-01  5.259E-01
MASKHA     4     2     4    12     3  3.687E-01  5.259E-01
MASKHA     5     2     4    12     3  3.687E-01  5.259E-01
MASKHA     6     2     4    12     3  3.687E-01  5.259E-01
MASKHA     7     2     4    12     3  3.687E-01  5.259E-01
MASKHA     8     2     4    12     3  3.687E-01  5.259E-01
MASKHA     9     2     4    12     3  3.687E-01  5.259E-01
MASKHA    10     2     4    12     3  3.687E-01  5.259E-01
MASKHA    11     2     4    12     3  3.687E-01  5.259E-01
MASKHA    12     2     4    12     3  3.687E-01  5.259E-01
MASKHA     0     3     4    12     3  3.687E-01  5.259E-01
MASKHA     1     3     4    12     3  3.687E-01  5.259E-01
MASKHA     2     3     4    12     3  3.687E-01  5.259E-01
MASKHA     3     3     4    12     3  3.687E-01  5.259E-01
MASKHA     4     3     4    12     3  3.687E-01  5.259E-01
MASKHA     5     3     4    12     3  3.687E-01  5.259E-01
MASKHA     6     3     4    12     3  3.687E-01  5.259E-01
MASKHA     7     3     4    12     3  3.687E-01  5.259E-01
MASKHA     8     3     4    12     3  3.687E-01  5.259E-01
MASKHA     9     3     4    12     3  3.687E-01  5.259E-01
MASKHA    10     3     4    12     3  3.687E-01  5.259E-01
MASKHA    11     3     4    12     3  3.687E-01  5.259E-01
MASKHA    12     3     4    12     3  3.687E-01  5.259E-01
MASKHA     0     0    12     3     4  0.000E+00  0.000E+00
MASKHA     1     0    12     3     4  0.000E+00  0.000E+00
MASKHA     2     0    12     3     4  0.000E+00  0.000E+00
MASKHA     3     0    12     3     4  0.000E+00  0.000E+00
MASKHA     0     1    12     3     4  3.052E-05  6.250E-02
MASKHA     1     1    12     3     4  3.052E-05  6.250E-02
MASKHA     2     1    12     3     4  3.052E-05  6.250E-02
MASKHA     3     1    12     3     4  3.052E-05  6.250E-02
MASKHA     0     2    12     3     4  0.000E+00  2.500E-01
MASKHA     1     2    12     3     4  0.000E+00  2.500E-01
MASKHA     2     2    12     3     4  0.000E+00  2.500E-01
MASKHA     3     2    12     3     4  0.000E+00  2.500E-01
MASKHA     0     3    12     3     4  0.000E+00  5.625E-01
MASKHA     1     3    12     3     4  2.590E-04  5.625E-01
MASKHA     2     3    12     3     4  2.590E-04  5.625E-01
MASKHA     3     3    12     3     4  0.000E+00  5.625E-01
MASKHA     0     4    12     3     4  0.000E+00  1.000E+00
MASKHA     1     4    12     3     4  3.453E-04  1.000E+00
MASKHA     2     4    12     3     4  0.000E+00  1.000E+00
MASKHA     3     4    12     3     4  0.000E+00  1.000E+00
MASKHA     0     0     3     4    12  0.000E+00  0.000E+00
MASKHA     1     0     3     4    12  0.000E+00  6.250E-02
MASKHA     2     0     3     4    12  0.000E+00  2.500E-01
MASKHA     3     0     3     4    12  0.000E+00  5.625E-01
MASKHA     4     0     3     4    12  0.000E+00  1.000E+00
MASKHA     0     1     3     4    12  0.000E+00  0.000E+00
MASKHA     1     1     3     4    12  0.000E+00  6.250E-02
MASKHA     2     1     3     4    12  0.000E+00  2.500E-01
MASKHA     3     1     3     4    12  0.000E+00  5.625E-01
MASKHA     4     1     3     4    12  0.000E+00  1.000E+00
MASKHA     0     2     3     4    12  0.000E+00  0.000E+00
MASKHA     1     2     3     4    12  0.000E+00  6.250E-02
MASKHA   2    2    3    4   12  0.000E+00  2.500E-01
MASKHA   3    2    3    4   12  0.000E+00  5.625E-01
MASKHA   4    2    3    4   12  3.453E-04  1.000E+00
MASKHA   0    3    3    4   12  0.000E+00  0.000E+00
MASKHA   1    3    3    4   12  0.000E+00  6.250E-02
MASKHA   2    3    3    4   12  0.000E+00  2.500E-01
MASKHA   3    3    3    4   12  0.000E+00  5.625E-01
MASKHA   4    3    3    4   12  0.000E+00  1.000E+00
MASKHA   0    4    3    4   12  0.000E+00  0.000E+00
MASKHA   1    4    3    4   12  2.158E-05  6.250E-02
MASKHA   2    4    3    4   12  8.632E-05  2.500E-01
MASKHA   3    4    3    4   12  0.000E+00  5.625E-01
MASKHA   4    4    3    4   12  0.000E+00  1.000E+00
MASKHA   0    5    3    4   12  0.000E+00  0.000E+00
MASKHA   1    5    3    4   12  0.000E+00  6.250E-02
MASKHA   2    5    3    4   12  0.000E+00  2.500E-01
MASKHA   3    5    3    4   12  0.000E+00  5.625E-01
MASKHA   4    5    3    4   12  0.000E+00  1.000E+00
MASKHA   0    6    3    4   12  0.000E+00  0.000E+00
MASKHA   1    6    3    4   12  0.000E+00  6.250E-02
MASKHA   2    6    3    4   12  0.000E+00  2.500E-01
MASKHA   3    6    3    4   12  0.000E+00  5.625E-01
MASKHA   4    6    3    4   12  0.000E+00  1.000E+00
MASKHA   0    7    3    4   12  0.000E+00  0.000E+00
MASKHA   1    7    3    4   12  0.000E+00  6.250E-02
MASKHA   2    7    3    4   12  0.000E+00  2.500E-01
MASKHA   3    7    3    4   12  0.000E+00  5.625E-01
MASKHA   4    7    3    4   12  0.000E+00  1.000E+00
MASKHA   0    8    3    4   12  0.000E+00  0.000E+00
MASKHA   1    8    3    4   12  0.000E+00  6.250E-02
MASKHA   2    8    3    4   12  8.632E-05  2.500E-01
MASKHA   3    8    3    4   12  0.000E+00  5.625E-01
MASKHA   4    8    3    4   12  0.000E+00  1.000E+00
MASKHA   0    9    3    4   12  0.000E+00  0.000E+00
MASKHA   1    9    3    4   12  0.000E+00  6.250E-02
MASKHA   2    9    3    4   12  0.000E+00  2.500E-01
MASKHA   3    9    3    4   12  0.000E+00  5.625E-01
MASKHA   4    9    3    4   12  0.000E+00  1.000E+00
MASKHA   0   10    3    4   12  0.000E+00  0.000E+00
MASKHA   1   10    3    4   12  0.000E+00  6.250E-02
MASKHA   2   10    3    4   12  0.000E+00  2.500E-01
MASKHA   3   10    3    4   12  0.000E+00  5.625E-01
MASKHA   4   10    3    4   12  0.000E+00  1.000E+00
MASKHA   0   11    3    4   12  0.000E+00  0.000E+00
MASKHA   1   11    3    4   12  0.000E+00  6.250E-02
MASKHA   2   11    3    4   12  0.000E+00  2.500E-01
MASKHA   3   11    3    4   12  0.000E+00  5.625E-01
MASKHA   4   11    3    4   12  0.000E+00  1.000E+00
MASKHA   0   12    3    4   12  0.000E+00  0.000E+00
MASKHA   1   12    3    4   12  0.000E+00  6.250E-02
MASKHA   2   12    3    4   12  0.000E+00  2.500E-01
MASKHA   3   12    3    4   12  0.000E+00  5.625E-01
MASKHA   4   12    3    4   12  0.000E+00  1.000E+00
```

```
variable spaced polar lattice
=============================

   E-SPACE =          32
 j,ecov(j)    1  0.000E+00
 j,ecov(j)    2  6.250E-02
 j,ecov(j)    3  1.875E-01
 j,ecov(j)    4  3.125E-01
 j,ecov(j)    5  4.375E-01
 j,ecov(j)    6  0.000E+00
 j,ecov(j)    7  6.944E-03
 j,ecov(j)    8  2.083E-02
 j,ecov(j)    9  3.472E-02
 j,ecov(j)   10  4.861E-02
 j,ecov(j)   11  6.250E-02
 j,ecov(j)   12  7.639E-02
 j,ecov(j)   13  9.028E-02
 j,ecov(j)   14  1.042E-01
 j,ecov(j)   15  1.181E-01
 j,ecov(j)   16  1.319E-01
 j,ecov(j)   17  1.458E-01
 j,ecov(j)   18  1.597E-01
 j,ecov(j)   19  0.000E+00
 j,ecov(j)   20  1.111E-01
 j,ecov(j)   21  3.333E-01
 j,ecov(j)   22  5.556E-01
 j,ecov(j)   23  0.000E+00
 j,ecov(j)   24  1.000E+00
 j,ecov(j)   25  0.000E+00
 j,ecov(j)   26  6.250E-02
 j,ecov(j)   27  2.500E-01
 j,ecov(j)   28  5.625E-01
 j,ecov(j)   29  1.000E+00
 j,ecov(j)   30  1.000E+00
 j,ecov(j)   31  0.000E+00
 j,ecov(j)   32  0.000E+00


  dir corner nos  pos 1loc 2loc 3loc  1-value    2-value    3-value

    1     0    0    0    1    6   11    0.000      0.000      0.000
    1     0    0    1    2    7   12    0.062      0.000      0.000
    1     0    0    2    3    8   13    0.250      0.000      0.000
    1     0    0    3    4    9   14    0.562      0.000      0.000
    1     0    0    4    5   10   15    1.000      0.000      0.000
    1     0    1    0   31   36   41    0.000      0.000      1.000
    1     0    1    1   32   37   42    0.062      0.000      1.000
    1     0    1    2   33   38   43    0.250      0.000      1.000
    1     0    1    3   34   39   44    0.562      0.000      1.000
    1     0    1    4   35   40   45    1.000      0.000      1.000
    1     1    0    0   16   21   26    0.000      1.000      0.000
    1     1    0    1   17   22   27    0.062      1.000      0.000
    1     1    0    2   18   23   28    0.250      1.000      0.000
    1     1    0    3   19   24   29    0.562      1.000      0.000
    1     1    0    4   20   25   30    1.000      1.000      0.000
   1     1     1     0   46    51    56      0.000      1.000      1.000
   1     1     1     1   47    52    57      0.062      1.000      1.000
   1     1     1     2   48    53    58      0.250      1.000      1.000
   1     1     1     3   49    54    59      0.562      1.000      1.000
   1     1     1     4   50    55    60      1.000      1.000      1.000
   2     0     0     0   61    74    87      0.000      0.000      0.000
   2     0     0     1   62    75    88      0.000      0.007      0.000
   2     0     0     2   63    76    89      0.000      0.028      0.000
   2     0     0     3   64    77    90      0.000      0.062      0.000
   2     0     0     4   65    78    91      0.000      0.111      0.000
   2     0     0     5   66    79    92      0.000      0.174      0.000
   2     0     0     6   67    80    93      0.000      0.250      0.000
   2     0     0     7   68    81    94      0.000      0.340      0.000
   2     0     0     8   69    82    95      0.000      0.444      0.000
   2     0     0     9   70    83    96      0.000      0.562      0.000
   2     0     0    10   71    84    97      0.000      0.694      0.000
   2     0     0    11   72    85    98      0.000      0.840      0.000
   2     0     0    12   73    86    99      0.000      1.000      0.000
   2     0     1     0  139   152   165      1.000      0.000      0.000
   2     0     1     1  140   153   166      1.000      0.007      0.000
   2     0     1     2  141   154   167      1.000      0.028      0.000
   2     0     1     3  142   155   168      1.000      0.062      0.000
   2     0     1     4  143   156   169      1.000      0.111      0.000
   2     0     1     5  144   157   170      1.000      0.174      0.000
   2     0     1     6  145   158   171      1.000      0.250      0.000
   2     0     1     7  146   159   172      1.000      0.340      0.000
   2     0     1     8  147   160   173      1.000      0.444      0.000
   2     0     1     9  148   161   174      1.000      0.562      0.000
   2     0     1    10  149   162   175      1.000      0.694      0.000
   2     0     1    11  150   163   176      1.000      0.840      0.000
   2     0     1    12  151   164   177      1.000      1.000      0.000
   2     1     0     0  100   113   126      0.000      0.000      1.000
   2     1     0     1  101   114   127      0.000      0.007      1.000
   2     1     0     2  102   115   128      0.000      0.028      1.000
   2     1     0     3  103   116   129      0.000      0.062      1.000
   2     1     0     4  104   117   130      0.000      0.111      1.000
   2     1     0     5  105   118   131      0.000      0.174      1.000
   2     1     0     6  106   119   132      0.000      0.250      1.000
   2     1     0     7  107   120   133      0.000      0.340      1.000
   2     1     0     8  108   121   134      0.000      0.444      1.000
   2     1     0     9  109   122   135      0.000      0.562      1.000
   2     1     0    10  110   123   136      0.000      0.694      1.000
   2     1     0    11  111   124   137      0.000      0.840      1.000
   2     1     0    12  112   125   138      0.000      1.000      1.000
   2     1     1     0  178   191   204      1.000      0.000      1.000
   2     1     1     1  179   192   205      1.000      0.007      1.000
   2     1     1     2  180   193   206      1.000      0.028      1.000
   2     1     1     3  181   194   207      1.000      0.062      1.000
   2     1     1     4  182   195   208      1.000      0.111      1.000
   2     1     1     5  183   196   209      1.000      0.174      1.000
   2     1     1     6  184   197   210      1.000      0.250      1.000
   2     1     1     7  185   198   211      1.000      0.340      1.000
   2     1     1     8  186   199   212      1.000      0.444      1.000
   2     1     1     9  187   200   213      1.000      0.562      1.000
   2     1     1    10  188   201   214      1.000      0.694      1.000
```

```
   2     1     1    11  189   202   215      1.000      0.840      1.000
   2     1     1    12  190   203   216      1.000      1.000      1.000
   3     0     0     0  217   221   225      0.000      0.000      0.000
   3     0     0     1  218   222   226      0.000      0.000      0.111
   3     0     0     2  219   223   227      0.000      0.000      0.444
   3     0     0     3  220   224   228      0.000      0.000      1.000
   3     0     1     0  241   245   249      0.000      1.000      0.000
   3     0     1     1  242   246   250      0.000      1.000      0.111
   3     0     1     2  243   247   251      0.000      1.000      0.444
   3     0     1     3  244   248   252      0.000      1.000      1.000
   3     1     0     0  229   233   237      1.000      0.000      0.000
   3     1     0     1  230   234   238      1.000      0.000      0.111
   3     1     0     2  231   235   239      1.000      0.000      0.444
   3     1     0     3  232   236   240      1.000      0.000      1.000
   3     1     1     0  253   257   261      1.000      1.000      0.000
   3     1     1     1  254   258   262      1.000      1.000      0.111
   3     1     1     2  255   259   263      1.000      1.000      0.444
   3     1     1     3  256   260   264      1.000      1.000      1.000


 BLOCK ADDRESSING SUMMARY, BLOCK    1
 ===================================

    Coordinate  Number of    Mesh      Origin
      Index      Elements  Increment
    ==========  =========  =========   ======


        1           4          5          1
        2          12         65        261
        3           3        260        521

 Dimensionality =  3

Cylindrical polar local reference coordinates

        Index      Increment 1 Increment 2 Increment 3    Origin
        =====      =========== =========== ===========    ======


          1             1          0           0           2
          2             0          0           0           1
          3             0          0           0           1
          4             0          0           0           1
          5             0          1           0           7
          6             0          0           0           1
          7             0          0           0           1
          8             0          0           0           1
          9             0          0           1          20
         10             0          0           0          24
         11             1          0           0          25
         12             0          0           0          30
 VPNX        = -1.0000E+00
 VPNY        = -3.0000E-01
 VPNZ        =  7.0000E-01
 PLOTYPE    =           2

variable spaced cubic lattice
=============================

   E-SPACE =          25

 dir corner nos  pos 1loc 2loc 3loc  1-value    2-value    3-value

   1    0    0    0    1    6   11    0.000      0.000      0.000
   1    0    0    1    2    7   12    0.062      0.000      0.000
   1    0    0    2    3    8   13    0.250      0.000      0.000
   1    0    0    3    4    9   14    0.562      0.000      0.000
   1    0    0    4    5   10   15    1.000      0.000      0.000
   1    0    1    0   31   36   41    0.000      0.000      1.000
   1    0    1    1   32   37   42    0.062      0.000      1.000
   1    0    1    2   33   38   43    0.250      0.000      1.000
   1    0    1    3   34   39   44    0.562      0.000      1.000
   1    0    1    4   35   40   45    1.000      0.000      1.000
   1    1    0    0   16   21   26    0.000      1.000      0.000
   1    1    0    1   17   22   27    0.062      1.000      0.000
   1    1    0    2   18   23   28    0.250      1.000      0.000
   1    1    0    3   19   24   29    0.562      1.000      0.000
   1    1    0    4   20   25   30    1.000      1.000      0.000
   1    1    1    0   46   51   56    0.000      1.000      1.000
   1    1    1    1   47   52   57    0.062      1.000      1.000
   1    1    1    2   48   53   58    0.250      1.000      1.000
   1    1    1    3   49   54   59    0.562      1.000      1.000
   1    1    1    4   50   55   60    1.000      1.000      1.000
   2    0    0    0   61   67   73    0.000      0.000      0.000
   2    0    0    1   62   68   74    0.000      0.040      0.000
   2    0    0    2   63   69   75    0.000      0.160      0.000
   2    0    0    3   64   70   76    0.000      0.360      0.000
   2    0    0    4   65   71   77    0.000      0.640      0.000
   2    0    0    5   66   72   78    0.000      1.000      0.000
   2    0    1    0   97  103  109    1.000      0.000      0.000
   2    0    1    1   98  104  110    1.000      0.040      0.000
   2    0    1    2   99  105  111    1.000      0.160      0.000
   2    0    1    3  100  106  112    1.000      0.360      0.000
   2    0    1    4  101  107  113    1.000      0.640      0.000
   2    0    1    5  102  108  114    1.000      1.000      0.000
   2    1    0    0   79   85   91    0.000      0.000      1.000
   2    1    0    1   80   86   92    0.000      0.040      1.000
   2    1    0    2   81   87   93    0.000      0.160      1.000
   2    1    0    3   82   88   94    0.000      0.360      1.000
   2    1    0    4   83   89   95    0.000      0.640      1.000
   2    1    0    5   84   90   96    0.000      1.000      1.000
   2    1    1    0  115  121  127    1.000      0.000      1.000
   2    1    1    1  116  122  128    1.000      0.040      1.000
   2    1    1    2  117  123  129    1.000      0.160      1.000
   2    1    1    3  118  124  130    1.000      0.360      1.000
   2    1    1    4  119  125  131    1.000      0.640      1.000
   2    1    1    5  120  126  132    1.000      1.000      1.000
   3    0    0    0  133  137  141    0.000      0.000      0.000
   3    0    0    1  134  138  142    0.000      0.000      0.111
   3    0    0    2  135  139  143    0.000      0.000      0.444
   3    0    0    3  136  140  144    0.000      0.000      1.000
   3    0    1    0  157  161  165    0.000      1.000      0.000
   3    0    1    1  158  162  166    0.000      1.000      0.111
   3    0    1    2  159  163  167    0.000      1.000      0.444
   3    0    1    3  160  164  168    0.000      1.000      1.000
   3    1    0    0  145  149  153    1.000      0.000      0.000
   3    1    0    1  146  150  154    1.000      0.000      0.111
   3    1    0    2  147  151  155    1.000      0.000      0.444
   3    1    0    3  148  152  156    1.000      0.000      1.000
   3    1    1    0  169  173  177    1.000      1.000      0.000
   3    1    1    1  170  174  178    1.000      1.000      0.111
   3    1    1    2  171  175  179    1.000      1.000      0.444
   3    1    1    3  172  176  180    1.000      1.000      1.000


 BLOCK ADDRESSING SUMMARY, BLOCK    1
 ===================================

    Coordinate  Number of    Mesh      Origin
      Index      Elements  Increment
    ==========  =========  =========   ======


        1           4          5          1
        2           5         30        121
        3           3        120        241

 Dimensionality =  3

Cartesian local reference coordinates

        Index       Increment 1 Increment 2 Increment 3    Origin
        =====       =========== =========== ===========    ======


          1            1           0           0            2
          2            0           0           0            1
          3            0           0           0            1
          4            0           0           0            1
          5            0           1           0            7
          6            0           0           0            1
          7            0           0           0            1
          8            0           0           0            1
          9            0           0           1           13
         10            0           0           0           17
         11            1           0           0           18
         12            0           0           0           23
 VPNX        = -1.0000E+00
 VPNY        = -3.0000E-01
 VPNZ        =  7.0000E-01
 PLOTYPE    =          2


polar mesh segment
==================

   E-SPACE =          83


 dir corner nos  pos 1loc 2loc 3loc  1-value    2-value    3-value

   1    0    0    0    1    6   11    0.500      0.000     -0.500
   1    0    0    1    2    7   12    0.625      0.000     -0.500
   1    0    0    2    3    8   13    0.750      0.000     -0.500
   1    0    0    3    4    9   14    0.875      0.000     -0.500
   1    0    0    4    5   10   15    1.000      0.000     -0.500
   1    0    1    0   31   36   41    0.500      0.000      0.500
   1    0    1    1   32   37   42    0.625      0.000      0.500
   1    0    1    2   33   38   43    0.750      0.000      0.500
   1    0    1    3   34   39   44    0.875      0.000      0.500
   1    0    1    4   35   40   45    1.000      0.000      0.500
   1    1    0    0   16   21   26    0.250      0.433     -0.500
   1    1    0    1   17   22   27    0.312      0.541     -0.500
   1    1    0    2   18   23   28    0.375      0.650     -0.500
   1    1    0    3   19   24   29    0.437      0.758     -0.500
   1    1    0    4   20   25   30    0.500      0.866     -0.500
   1    1    1    0   46   51   56    0.250      0.433      0.500
   1    1    1    1   47   52   57    0.312      0.541      0.500
   1    1    1    2   48   53   58    0.375      0.650      0.500
   1    1    1    3   49   54   59    0.437      0.758      0.500
   1    1    1    4   50   55   60    0.500      0.866      0.500
   2    0    0    0   61   67   73    0.500      0.000     -0.500
   2    0    0    1   62   68   74    0.489      0.104     -0.500
   2    0    0    2   63   69   75    0.457      0.203     -0.500
   2    0    0    3   64   70   76    0.405      0.294     -0.500
   2    0    0    4   65   71   77    0.335      0.372     -0.500
   2    0    0    5   66   72   78    0.250      0.433     -0.500
   2    0    1    0   97  103  109    1.000      0.000     -0.500
   2    0    1    1   98  104  110    0.978      0.208     -0.500
   2    0    1    2   99  105  111    0.914      0.407     -0.500
   2    0    1    3  100  106  112    0.809      0.588     -0.500
   2    0    1    4  101  107  113    0.669      0.743     -0.500
   2    0    1    5  102  108  114    0.500      0.866     -0.500
   2    1    0    0   79   85   91    0.500      0.000      0.500
   2    1    0    1   80   86   92    0.489      0.104      0.500
   2    1    0    2   81   87   93    0.457      0.203      0.500
   2    1    0    3   82   88   94    0.405      0.294      0.500
   2    1    0    4   83   89   95    0.335      0.372      0.500
   2    1    0    5   84   90   96    0.250      0.433      0.500
   2    1    1    0  115  121  127    1.000      0.000      0.500
   2    1    1    1  116  122  128    0.978      0.208      0.500
   2    1    1    2  117  123  129    0.914      0.407      0.500
   2    1    1    3  118  124  130    0.809      0.588      0.500
   2    1    1    4  119  125  131    0.669      0.743      0.500
   2    1    1    5  120  126  132    0.500      0.866      0.500
```

```
   3    0    0    0  133  137  141    0.500      0.000     -0.500
   3    0    0    1  134  138  142    0.500      0.000     -0.167
   3    0    0    2  135  139  143    0.500      0.000      0.167
   3    0    0    3  136  140  144    0.500      0.000      0.500
   3    0    1    0  157  161  165    0.250      0.433     -0.500
   3    0    1    1  158  162  166    0.250      0.433     -0.167
   3    0    1    2  159  163  167    0.250      0.433      0.167
   3    0    1    3  160  164  168    0.250      0.433      0.500
   3    1    0    0  145  149  153    1.000      0.000     -0.500
   3    1    0    1  146  150  154    1.000      0.000     -0.167
   3    1    0    2  147  151  155    1.000      0.000      0.167
   3    1    0    3  148  152  156    1.000      0.000      0.500
   3    1    1    0  169  173  177    0.500      0.866     -0.500
   3    1    1    1  170  174  178    0.500      0.866     -0.167
   3    1    1    2  171  175  179    0.500      0.866      0.167
   3    1    1    3  172  176  180    0.500      0.866      0.500


 BLOCK ADDRESSING SUMMARY, BLOCK    1
 ===================================

    Coordinate  Number of    Mesh      Origin
      Index      Elements  Increment
    ==========  =========  =========   ======


        1           4          5          1
        2           5         30        121
        3           3        120        241

 Dimensionality =  3

Cartesian local reference coordinates

         Index       Increment 1 Increment 2 Increment 3     Origin
         =====       =========== =========== ===========     ======


           1              0          1           0            2
           2              0          1           0            8
           3              0          0           0            1
           4              1          5           0           14
           5              1          5           0           44
           6              0          0           0            1
           7              0          0           0            1
           8              0          0           0            1
           9              0          0           0           74
          10              0          0           0           75
          11              1          0           0           76
          12              0          0           0           81
  VPNX        = -1.0000E+00
  VPNY        = -3.0000E-01
  VPNZ        =  7.0000E-01

 PLOTYPE    =          2
```

```
polar to rectangular transition
===============================

   E-SPACE =          83

 dir corner nos  pos 1loc 2loc 3loc  1-value   2-value   3-value

   1    0    0    0    1    6   11    0.500     0.000    -0.500
   1    0    0    1    2    7   12    0.750     0.000    -0.500
   1    0    0    2    3    8   13    1.000     0.000    -0.500
   1    0    0    3    4    9   14    1.250     0.000    -0.500
   1    0    0    4    5   10   15    1.500     0.000    -0.500
   1    0    1    0   31   36   41    0.500     0.000     0.500
   1    0    1    1   32   37   42    0.750     0.000     0.500
   1    0    1    2   33   38   43    1.000     0.000     0.500
   1    0    1    3   34   39   44    1.250     0.000     0.500
   1    0    1    4   35   40   45    1.500     0.000     0.500
   1    1    0    0   16   21   26    0.250     0.433    -0.500
   1    1    0    1   17   22   27    0.375     0.650    -0.500
   1    1    0    2   18   23   28    0.500     0.866    -0.500
   1    1    0    3   19   24   29    0.625     1.083    -0.500
   1    1    0    4   20   25   30    0.750     1.299    -0.500
   1    1    1    0   46   51   56    0.250     0.433     0.500
   1    1    1    1   47   52   57    0.375     0.650     0.500
   1    1    1    2   48   53   58    0.500     0.866     0.500
   1    1    1    3   49   54   59    0.625     1.083     0.500
   1    1    1    4   50   55   60    0.750     1.299     0.500
   2    0    0    0   61   67   73    0.500     0.000    -0.500
   2    0    0    1   62   68   74    0.489     0.104    -0.500
   2    0    0    2   63   69   75    0.457     0.203    -0.500
   2    0    0    3   64   70   76    0.405     0.294    -0.500
   2    0    0    4   65   71   77    0.335     0.372    -0.500
   2    0    0    5   66   72   78    0.250     0.433    -0.500
   2    0    1    0   97  103  109    1.500     0.000    -0.500
   2    0    1    1   98  104  110    1.350     0.260    -0.500
   2    0    1    2   99  105  111    1.200     0.520    -0.500
   2    0    1    3  100  106  112    1.050     0.779    -0.500
   2    0    1    4  101  107  113    0.900     1.039    -0.500
   2    0    1    5  102  108  114    0.750     1.299    -0.500
   2    1    0    0   79   85   91    0.500     0.000     0.500
   2    1    0    1   80   86   92    0.489     0.104     0.500
   2    1    0    2   81   87   93    0.457     0.203     0.500
   2    1    0    3   82   88   94    0.405     0.294     0.500
   2    1    0    4   83   89   95    0.335     0.372     0.500
   2    1    0    5   84   90   96    0.250     0.433     0.500
   2    1    1    0  115  121  127    1.500     0.000     0.500
   2    1    1    1  116  122  128    1.350     0.260     0.500
   2    1    1    2  117  123  129    1.200     0.520     0.500
   2    1    1    3  118  124  130    1.050     0.779     0.500
   2    1    1    4  119  125  131    0.900     1.039     0.500
   2    1    1    5  120  126  132    0.750     1.299     0.500
   3    0    0    0  133  137  141    0.500     0.000    -0.500
```

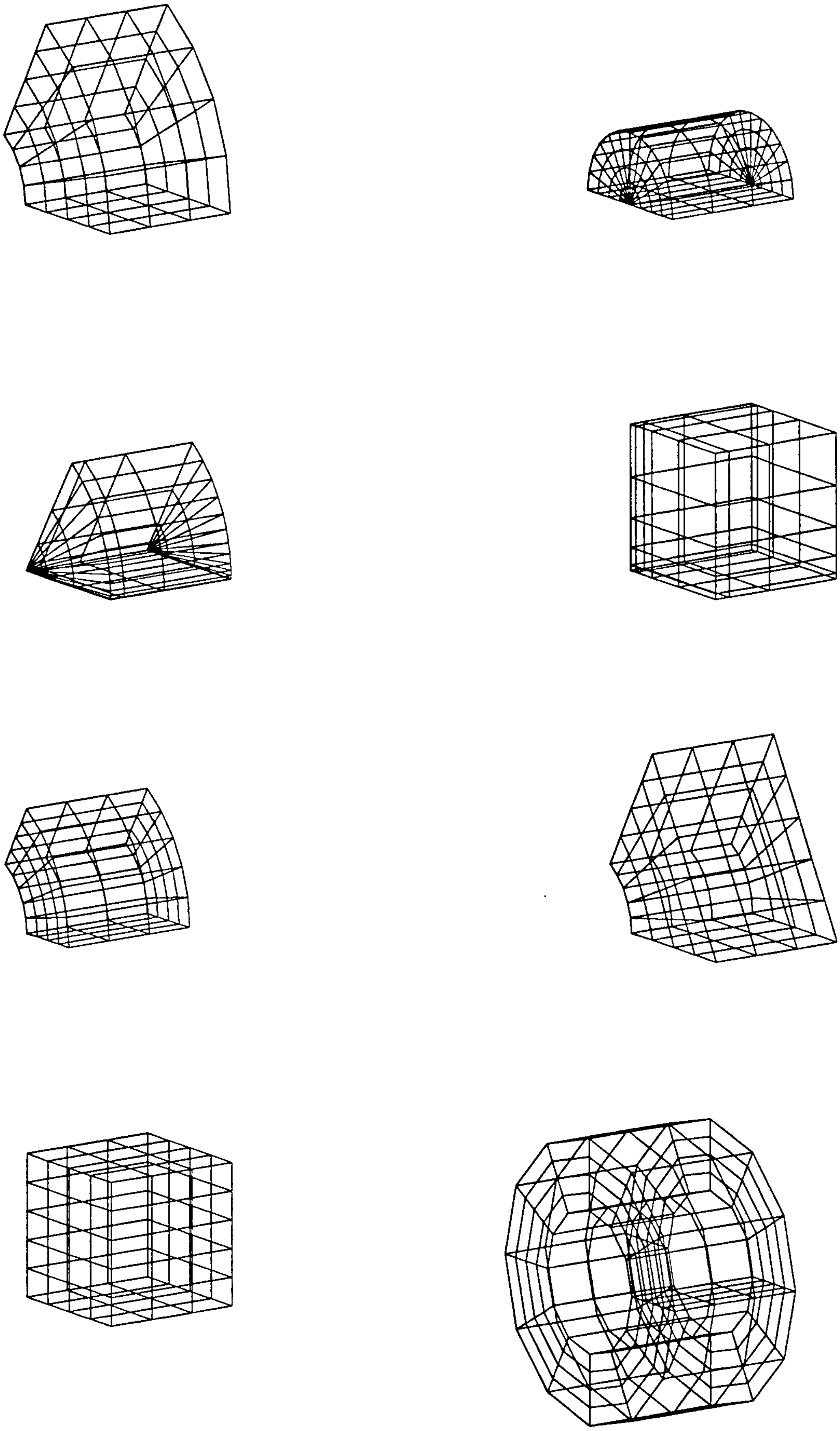
```
   3    0    0    1  134  138  142    0.500     0.000    -0.167
   3    0    0    2  135  139  143    0.500     0.000     0.167
   3    0    0    3  136  140  144    0.500     0.000     0.500
   3    0    1    0  157  161  165    0.250     0.433    -0.500
   3    0    1    1  158  162  166    0.250     0.433    -0.167
   3    0    1    2  159  163  167    0.250     0.433     0.167
   3    0    1    3  160  164  168    0.250     0.433     0.500
   3    1    0    0  145  149  153    1.500     0.000    -0.500
   3    1    0    1  146  150  154    1.500     0.000    -0.167
   3    1    0    2  147  151  155    1.500     0.000     0.167
   3    1    0    3  148  152  156    1.500     0.000     0.500
   3    1    1    0  169  173  177    0.750     1.299    -0.500
   3    1    1    1  170  174  178    0.750     1.299    -0.167
   3    1    1    2  171  175  179    0.750     1.299     0.167
   3    1    1    3  172  176  180    0.750     1.299     0.500


 BLOCK ADDRESSING SUMMARY, BLOCK    1
 ===================================

     Coordinate  Number of    Mesh      Origin
       Index     Elements   Increment
     ==========  =========  =========   ======


         1           4          5          1
         2           5         30        121
         3           3        120        241

 Dimensionality =  3

Cartesian local reference coordinates

        Index      Increment 1 Increment 2 Increment 3     Origin
        =====      =========== =========== ===========     ======


          1            0           1           0            2
          2            0           1           0            8
          3            0           0           0            1
          4            1           5           0           14
          5            1           5           0           44
          6            0           0           0            1
          7            0           0           0            1
          8            0           0           0            1
          9            0           0           0           74
         10            0           0           0           75
         11            1           0           0           76
         12            0           0           0           81
  VPNX        = -1.0000E+00
  VPNY        = -3.0000E-01
  VPNZ        =  7.0000E-01

 PLOTYPE     =           2
```

```
regular cubic lattice
=====================

   E-SPACE =           7

  BLOCK ADDRESSING SUMMARY, BLOCK    1
  ====================================

      Coordinate  Number of    Mesh      Origin
        Index      Elements  Increment
      ==========  =========  =========   ======


          1           4          5          1
          2           5         30        121
          3           3        120        241

  Dimensionality =  3

 Cartesian local reference coordinates

        Index      Increment 1 Increment 2 Increment 3     Origin
        =====      =========== =========== ===========     ======


            1           0           0           0           2
            2           0           0           0           1
            3           0           0           0           1
            4           0           0           0           1
            5           0           0           0           3
            6           0           0           0           1
            7           0           0           0           1
            8           0           0           0           1
            9           0           0           0           4
           10           0           0           0           5
           11           0           0           0           5
           12           0           0           0           5
   VPNX        = -1.0000E+00
   VPNY        = -3.0000E-01
   VPNZ        =  7.0000E-01

  PLOTYPE    =            2


polar mesh coaxial line
=======================

   E-SPACE =         163


  dir corner nos  pos 1loc 2loc 3loc  1-value   2-value   3-value

   1    0    0    0    1    6   11     0.500     0.000    -0.500
```

```
 1    0    0    1    2    7   12     0.625     0.000    -0.500
 1    0    0    2    3    8   13     0.750     0.000    -0.500
 1    0    0    3    4    9   14     0.875     0.000    -0.500
 1    0    0    4    5   10   15     1.000     0.000    -0.500
 1    0    1    0   31   36   41     0.500     0.000     0.500
 1    0    1    1   32   37   42     0.625     0.000     0.500
 1    0    1    2   33   38   43     0.750     0.000     0.500
 1    0    1    3   34   39   44     0.875     0.000     0.500
 1    0    1    4   35   40   45     1.000     0.000     0.500
 1    1    0    0   16   21   26     0.500     0.000    -0.500
 1    1    0    1   17   22   27     0.625     0.000    -0.500
 1    1    0    2   18   23   28     0.750     0.000    -0.500
 1    1    0    3   19   24   29     0.875     0.000    -0.500
 1    1    0    4   20   25   30     1.000     0.000    -0.500
 1    1    1    0   46   51   56     0.500     0.000     0.500
 1    1    1    1   47   52   57     0.625     0.000     0.500
 1    1    1    2   48   53   58     0.750     0.000     0.500
 1    1    1    3   49   54   59     0.875     0.000     0.500
 1    1    1    4   50   55   60     1.000     0.000     0.500
 2    0    0    0   61   74   87     0.500     0.000    -0.500
 2    0    0    1   62   75   88     0.433     0.250    -0.500
 2    0    0    2   63   76   89     0.250     0.433    -0.500
 2    0    0    3   64   77   90     0.000     0.500    -0.500
 2    0    0    4   65   78   91    -0.250     0.433    -0.500
 2    0    0    5   66   79   92    -0.433     0.250    -0.500
 2    0    0    6   67   80   93    -0.500     0.000    -0.500
 2    0    0    7   68   81   94    -0.433    -0.250    -0.500
 2    0    0    8   69   82   95    -0.250    -0.433    -0.500
 2    0    0    9   70   83   96     0.000    -0.500    -0.500
 2    0    0   10   71   84   97     0.250    -0.433    -0.500
 2    0    0   11   72   85   98     0.433    -0.250    -0.500
 2    0    0   12   73   86   99     0.500     0.000    -0.500
 2    0    1    0  139  152  165     1.000     0.000    -0.500
 2    0    1    1  140  153  166     0.866     0.500    -0.500
 2    0    1    2  141  154  167     0.500     0.866    -0.500
 2    0    1    3  142  155  168     0.000     1.000    -0.500
 2    0    1    4  143  156  169    -0.500     0.866    -0.500
 2    0    1    5  144  157  170    -0.866     0.500    -0.500
 2    0    1    6  145  158  171    -1.000     0.000    -0.500
 2    0    1    7  146  159  172    -0.866    -0.500    -0.500
 2    0    1    8  147  160  173    -0.500    -0.866    -0.500
 2    0    1    9  148  161  174     0.000    -1.000    -0.500
 2    0    1   10  149  162  175     0.500    -0.866    -0.500
 2    0    1   11  150  163  176     0.866    -0.500    -0.500
 2    0    1   12  151  164  177     1.000     0.000    -0.500
 2    1    0    0  100  113  126     0.500     0.000     0.500
 2    1    0    1  101  114  127     0.433     0.250     0.500
 2    1    0    2  102  115  128     0.250     0.433     0.500
 2    1    0    3  103  116  129     0.000     0.500     0.500
 2    1    0    4  104  117  130    -0.250     0.433     0.500
 2    1    0    5  105  118  131    -0.433     0.250     0.500
 2    1    0    6  106  119  132    -0.500     0.000     0.500
 2    1    0    7  107  120  133    -0.433    -0.250     0.500
 2    1    0    8  108  121  134    -0.250    -0.433     0.500
 2    1    0    9  109  122  135     0.000    -0.500     0.500
```

```
   2    1    0   10  110  123  136     0.250    -0.433     0.500
   2    1    0   11  111  124  137     0.433    -0.250     0.500
   2    1    0   12  112  125  138     0.500     0.000     0.500
   2    1    1    0  178  191  204     1.000     0.000     0.500
   2    1    1    1  179  192  205     0.866     0.500     0.500
   2    1    1    2  180  193  206     0.500     0.866     0.500
   2    1    1    3  181  194  207     0.000     1.000     0.500
   2    1    1    4  182  195  208    -0.500     0.866     0.500
   2    1    1    5  183  196  209    -0.866     0.500     0.500
   2    1    1    6  184  197  210    -1.000     0.000     0.500
   2    1    1    7  185  198  211    -0.866    -0.500     0.500
   2    1    1    8  186  199  212    -0.500    -0.866     0.500
   2    1    1    9  187  200  213     0.000    -1.000     0.500
   2    1    1   10  188  201  214     0.500    -0.866     0.500
   2    1    1   11  189  202  215     0.866    -0.500     0.500
   2    1    1   12  190  203  216     1.000     0.000     0.500
   3    0    0    0  217  221  225     0.500     0.000    -0.500
   3    0    0    1  218  222  226     0.500     0.000    -0.167
   3    0    0    2  219  223  227     0.500     0.000     0.167
   3    0    0    3  220  224  228     0.500     0.000     0.500
   3    0    1    0  241  245  249     0.500     0.000    -0.500
   3    0    1    1  242  246  250     0.500     0.000    -0.167
   3    0    1    2  243  247  251     0.500     0.000     0.167
   3    0    1    3  244  248  252     0.500     0.000     0.500
   3    1    0    0  229  233  237     1.000     0.000    -0.500
   3    1    0    1  230  234  238     1.000     0.000    -0.167
   3    1    0    2  231  235  239     1.000     0.000     0.167
   3    1    0    3  232  236  240     1.000     0.000     0.500
   3    1    1    0  253  257  261     1.000     0.000    -0.500
   3    1    1    1  254  258  262     1.000     0.000    -0.167
   3    1    1    2  255  259  263     1.000     0.000     0.167
   3    1    1    3  256  260  264     1.000     0.000     0.500


 BLOCK ADDRESSING SUMMARY, BLOCK    1
 ====================================

     Coordinate  Number of     Mesh      Origin
       Index     Elements   Increment
     ==========  =========  =========    ======


          1          4          5          1
          2         12         65        261
          3          3        260        521

 Dimensionality =  3

Cartesian local reference coordinates

        Index      Increment 1 Increment 2 Increment 3     Origin
        =====      =========== =========== ===========     ======


          1            0           1           0           2
```

```
          2           0           1           0          15
          3           0           0           0           1
          4           1           5           0          28
          5           1           5           0          93
          6           0           0           0           1
          7           0           0           0           1
          8           0           0           0           1
          9           0           0           0         158
         10           0           0           0         159
         11           0           0           0         160
         12           0           0           0         161
  VPNX        = -1.0000E+00
  VPNY        = -3.0000E-01
  VPNZ        =  7.0000E-01

 PLOTYPE     =           2
    Elapse time so far =  3.8800E+00 secs:-
    user =  3.7300E+00 secs
    system =  1.1300E+00 secs
```



G NETGLB unit test data

```
rfesunh% xtest mtest.dat
  iblock =    1


      1 1    1.000E+00      2 1    0.000E+00      3 1    0.000E+00
      1 2    0.000E+00      2 2    1.000E+00      3 2    0.000E+00
      1 3    0.000E+00      2 3    0.000E+00      3 3    1.000E+00
  iblock =    2


      1 1    1.000E+00      2 1    0.000E+00      3 1    0.000E+00
      1 2    6.119E-08      2 2    1.000E+00      3 2    0.000E+00
      1 3    0.000E+00      2 3    0.000E+00      3 3    1.000E+00
  iblock =    3


      1 1    6.691E-01      2 1   -7.431E-01      3 1    0.000E+00
      1 2    7.431E-01      2 2    6.691E-01      3 2    0.000E+00
      1 3    0.000E+00      2 3    0.000E+00      3 3    1.000E+00
  iblock =    4


      1 1   -5.000E-01      2 1   -8.660E-01      3 1    0.000E+00
      1 2    8.660E-01      2 2   -5.000E-01      3 2    0.000E+00
      1 3    0.000E+00      2 3    0.000E+00      3 3    1.000E+00
  iblock =    5


      1 1   -9.781E-01      2 1   -2.079E-01      3 1    0.000E+00
      1 2    2.079E-01      2 2   -9.781E-01      3 2    0.000E+00
      1 3    0.000E+00      2 3    0.000E+00      3 3    1.000E+00
  iblock =    6


      1 1   -5.000E-01      2 1    8.660E-01      3 1    0.000E+00
      1 2   -8.660E-01      2 2   -5.000E-01      3 2    0.000E+00
      1 3    0.000E+00      2 3    0.000E+00      3 3    1.000E+00
  iblock =    7


      1 1    3.090E-01      2 1    9.511E-01      3 1    0.000E+00
      1 2   -9.511E-01      2 2    3.090E-01      3 2    0.000E+00
      1 3    0.000E+00      2 3    0.000E+00      3 3    1.000E+00
   VPNX         = -1.0000E+00
/
   VPNY         = -3.0000E-01
/
   VPNZ         =  7.0000E-01
/
   VRCX         =  0.0000E+00
/
   VRCY         =  0.0000E+00
/
   VRCZ         =  0.0000E+00
/
```

```
   VUPX         =  0.0000E+00
/
   VUPY         =  1.0000E+00
/
   VUPZ         =  0.0000E+00
/
   xmin map     = -1.2500E-01
/
   xmax map     =  1.2500E-01
/
   ymin map     = -1.2500E-01
/
   ymax map     =  1.2500E-01
/

  plotype    =             2
/
another projection? y/n
y
   VPNX         = -1.0000E+00
/
   VPNY         = -3.0000E-01
/
   VPNZ         =  7.0000E-01
/
   VRCX         =  0.0000E+00
/
   VRCY         =  0.0000E+00
/
   VRCZ         =  0.0000E+00
/
   VUPX         =  0.0000E+00
/
   VUPY         =  1.0000E+00
/
   VUPZ         =  0.0000E+00
/
   xmin map     = -1.2500E-01
/
   xmax map     =  1.2500E-01
/
   ymin map     = -1.2500E-01
/
   ymax map     =  1.2500E-01
/

  plotype    =             2
3
  plotype CHANGED TO             3
another projection? y/n
y
   VPNX         = -1.0000E+00
/
   VPNY         = -3.0000E-01
0
```

```
  VPNY      CHANGED TO   0.0000E+00
   VPNZ         =  7.0000E-01
0
  VPNZ      CHANGED TO   0.0000E+00
   VRCX         =  0.0000E+00
/
   VRCY         =  0.0000E+00
/
   VRCZ         =  0.0000E+00
/
   VUPX         =  0.0000E+00
/
   VUPY         =  1.0000E+00
/
   VUPZ         =  0.0000E+00
/
   xmin map     = -1.2500E-01
/
   xmax map     =  1.2500E-01
/
   ymin map     = -1.2500E-01
/
   ymax map     =  1.2500E-01
/

  plotype    =            2
/
another projection? y/n
y
   VPNX         = -1.0000E+00
0
  VPNX      CHANGED TO   0.0000E+00
   VPNY         =  0.0000E+00
/
   VPNZ         =  0.0000E+00
1
  VPNZ      CHANGED TO   1.0000E+00
   VRCX         =  0.0000E+00
/
   VRCY         =  0.0000E+00
/
   VRCZ         =  0.0000E+00
/
   VUPX         =  0.0000E+00
/
   VUPY         =  1.0000E+00
/
   VUPZ         =  0.0000E+00
/
   xmin map     = -1.2500E-01
/
   xmax map     =  1.2500E-01
/
   ymin map     = -1.2500E-01
/
   ymax map     =  1.2500E-01
/

  plotype    =            2
/
another projection? y/n
n
```

```
o_mtest
'NLRES  L  False for NEWRUN,True for RESET' /
mtest
Mesh assembly test
central cylinder + 6 outer segments
cylindrical local coords
J W Eastwood
'CHLAB5 A  **Label available to programmer           1.2 ' /
'NDIARY I  **Channel for diary                       1.1 ' /
'NIN    I  **Current input channel                   1.1 ' /
'NLEDGE I  **Channel for restart records             1.1 ' /
'NONLIN I  **Channel for input-output                1.1 ' /
'NOUT   I  **Current output channel                  1.1 ' /
'NPRINT I  **Channel for printed output              1.1 ' /
'NPUNCH I  **Channel for card output (or equivalent) 1.1 ' /
'NREC   I  **Current record number                   1.1 ' /
'NRUN   I  **Maximum number of steps                 1.1 ' /
'NADUMP IA **Codes for array dumps                   1.9 ' /
'NPDUMP IA **Codes for dumping points                1.9 ' /
'NVDUMP IA **Codes for dumping arrays                1.9 ' /
'NLCHED L  **.TRUE. if class 0 report-head required  1.9 ' /
'NLHEAD LA **.TRUE. if class 1-9 report-heads required 1.9 ' /
'NLOMT1 LA **Class 1 subprogram selector             1.9 ' /
'NLOMT2 LA **Class 2 subprogram selector             1.9 ' /
'NLOMT3 LA **Class 3 subprogram selector             1.9 ' /
'NLREPT L  **.TRUE. if report required               1.9 ' /
'C1     R  *real variable included in NEWRUN data    2.2 ' /
```

```
       UNIX - OLYMPUS ENVIRONMENT
       UNIX Version 1S       Dec 1989   CULHAM
       James W EASTWOOD and Wayne ARTER
       0.1 BASIC CONTROL DATA SET
 NLRES    =           F (          F ) : NLRES  L  False for NEWRUN,True for RESET
Input file = mtest.dat
       0.2 STANDARD DATA ACCEPTED
     11:26:11  16-Sep-94




                                                     P R O G R A M   T E S T
                                                     ***********************



           mtest

           Mesh assembly test

           central cylinder + 6 outer segments

           cylindrical local coords

           J W Eastwood



  PROCESS NUMBER   1
  =================


 BLOCK NUMBER =    1
 ==================

 BLOCK TYPE   =    1
 PROCESS      =    1
 PROCESSOR    =    1



 BLOCK CORNER NODE COORDINATES


 X000 = (  0.000E+00, 0.000E+00, 0.000E+00)
 X100 = (  2.000E-02, 0.000E+00, 0.000E+00)
 X010 = (  0.000E+00, 0.000E+00, 0.000E+00)
```

```
X001 = (  0.000E+00, 0.000E+00, 1.000E-01)


BLOCK NUMBER   1 - PATCH SUMMARY
----------------

      patch no  type no  block 1   block 2    O-1 key    X-1 key   O-2 key    X-2 key
      --------  -------  -------   -------    -------    -------   -------    -------

         14         2        1         7   4000000    4000003      3000       3003
         13         2        1         2   4015000    4015003         0          3
          6         2        1         7   4012000    4015000         0       3003
          5         2        1         6   4010000    4012000         0       2003
          4         2        1         5   4007000    4010000         0       3003
          3         2        1         4   4005000    4007000         0       2003
          2         2        1         3   4002000    4005000         0       3003
          1         2        1         2   4000000    4002000         0       2003

BLOCK NUMBER =    2
==================

BLOCK TYPE   =    2
PROCESS      =    1
PROCESSOR    =    1



BLOCK CORNER NODE COORDINATES


X000 = (  2.000E-02, 0.000E+00, 0.000E+00)
X100 = (  4.000E-02, 0.000E+00, 0.000E+00)
X010 = (  1.338E-02, 1.486E-02, 0.000E+00)
X001 = (  2.000E-02, 0.000E+00, 1.000E-01)


BLOCK NUMBER   2 - PATCH SUMMARY
----------------

      patch no  type no  block 1   block 2    O-1 key    X-1 key   O-2 key  , X-2 key
      --------  -------  -------   -------    -------    -------   -------    -------

         13         2        1         2   4015000    4015003         0          3
          8         1        7         2      3000    5003003         0    5000003
          7         1        2         3      2000    5002003         0    5000003
          1         2        1         2   4000000    4002000         0       2003

BLOCK NUMBER =    3
==================
BLOCK TYPE    =    3
PROCESS       =    1
PROCESSOR     =    1



BLOCK CORNER NODE COORDINATES


X000 = (  1.338E-02, 1.486E-02, 0.000E+00)
X100 = (  2.677E-02, 2.973E-02, 0.000E+00)
X010 = ( -1.000E-02, 1.732E-02, 0.000E+00)
X001 = (  1.338E-02, 1.486E-02, 1.000E-01)


BLOCK NUMBER   3 - PATCH SUMMARY
----------------

      patch no  type no  block 1   block 2    O-1 key    X-1 key  O-2 key   X-2 key
      --------  -------  -------   -------    -------    -------  -------   -------

         9         1        3         4        3000    5003003        0   5000003
         7         1        2         3        2000    5002003        0   5000003
         2         2        1         3     4002000    4005000        0      3003

BLOCK NUMBER =    4
==================

BLOCK TYPE    =    2
PROCESS       =    1
PROCESSOR     =    1



BLOCK CORNER NODE COORDINATES


X000 = ( -1.000E-02, 1.732E-02, 0.000E+00)
X100 = ( -2.000E-02, 3.464E-02, 0.000E+00)
X010 = ( -1.956E-02, 4.158E-03, 0.000E+00)
X001 = ( -1.000E-02, 1.732E-02, 1.000E-01)


BLOCK NUMBER   4 - PATCH SUMMARY
----------------

      patch no  type no  block 1   block 2    O-1 key    X-1 key  O-2 key   X-2 key
      --------  -------  -------   -------    -------    -------  -------   -------

        10         1        4         5        2000    5002003        0   5000003
```

```
         9         1         3         4      3000   5003003        0   5000003
         3         2         1         4   4005000   4007000        0      2003


BLOCK NUMBER =     5
===================

BLOCK TYPE    =    3
PROCESS       =    1
PROCESSOR     =    1



BLOCK CORNER NODE COORDINATES


X000 = ( -1.956E-02, 4.158E-03, 0.000E+00)
X100 = ( -3.913E-02, 8.316E-03, 0.000E+00)
X010 = ( -1.000E-02,-1.732E-02, 0.000E+00)
X001 = ( -1.956E-02, 4.158E-03, 1.000E-01)


BLOCK NUMBER   5 - PATCH SUMMARY
----------------

      patch no  type no  block 1   block 2    O-1 key   X-1 key  O-2 key   X-2 key
      --------  -------  -------   -------    -------   -------  -------   -------

         11         1         5         6      3000   5003003        0   5000003
         10         1         4         5      2000   5002003        0   5000003
          4         2         1         5   4007000   4010000        0      3003

BLOCK NUMBER =     6
===================

BLOCK TYPE    =    2
PROCESS       =    1
PROCESSOR     =    1



BLOCK CORNER NODE COORDINATES


X000 = ( -1.000E-02,-1.732E-02, 0.000E+00)
X100 = ( -2.000E-02,-3.464E-02, 0.000E+00)
X010 = (  6.180E-03,-1.902E-02, 0.000E+00)
X001 = ( -1.000E-02,-1.732E-02, 1.000E-01)
```

```
BLOCK NUMBER   6 - PATCH SUMMARY
----------------

      patch no  type no  block 1   block 2    O-1 key   X-1 key  O-2 key   X-2 key
      --------  -------  -------   -------    -------   -------  -------   -------

         12         1        6         7        2000   5002003        0   5000003
         11         1        5         6        3000   5003003        0   5000003
          5         2        1         6     4010000   4012000        0      2003


BLOCK NUMBER =    7
==================

BLOCK TYPE    =    3
PROCESS       =    1
PROCESSOR     =    1



BLOCK CORNER NODE COORDINATES


X000 = (   6.180E-03,-1.902E-02, 0.000E+00)
X100 = (   1.236E-02,-3.804E-02, 0.000E+00)
X010 = (   2.000E-02, 3.497E-09, 0.000E+00)
X001 = (   6.180E-03,-1.902E-02, 1.000E-01)


BLOCK NUMBER   7 - PATCH SUMMARY
----------------

      patch no  type no  block 1   block 2    O-1 key   X-1 key  O-2 key   X-2 key
      --------  -------  -------   -------    -------   -------  -------   -------

         14         2        1         7     4000000   4000003     3000      3003
         12         1        6         7        2000   5002003        0   5000003
          8         1        7         2        3000   5003003        0   5000003
          6         2        1         7     4012000   4015000        0      3003


 MESH STORAGE FOR PROCESS NUMBER    1
 ==============================


     INDEX      TYPE     ORIGIN    LENGTH

         1         1         0       960
         2         2         0       216
         3         3         0       288
         4         2         0       216
```

```
        5         3         0       288
        6         2         0       216
        7         3         0       288


 Field array length =   500000
 Total space used   =      287
 Total free space   =   499713

  VPNX       = -1.0000E+00
  VPNY       = -3.0000E-01
  VPNZ       =  7.0000E-01
  VRCX       =  0.0000E+00
  VRCY       =  0.0000E+00
  VRCZ       =  0.0000E+00
  VUPX       =  0.0000E+00
  VUPY       =  1.0000E+00
  VUPZ       =  0.0000E+00
  xmin map   = -1.2500E-01
  xmax map   =  1.2500E-01
  ymin map   = -1.2500E-01
  ymax map   =  1.2500E-01

 plotype   =           2
  VPNX       = -1.0000E+00
  VPNY       = -3.0000E-01
  VPNZ       =  7.0000E-01
  VRCX       =  0.0000E+00
  VRCY       =  0.0000E+00
  VRCZ       =  0.0000E+00
  VUPX       =  0.0000E+00
  VUPY       =  1.0000E+00
  VUPZ       =  0.0000E+00
  xmin map   = -1.2500E-01
  xmax map   =  1.2500E-01
  ymin map   = -1.2500E-01
  ymax map   =  1.2500E-01
 plotype CHANGED TO            3
  VPNX       = -1.0000E+00
 VPNY     CHANGED TO   0.0000E+00
 VPNZ     CHANGED TO   0.0000E+00
  VRCX       =  0.0000E+00
  VRCY       =  0.0000E+00
  VRCZ       =  0.0000E+00
  VUPX       =  0.0000E+00
  VUPY       =  1.0000E+00
  VUPZ       =  0.0000E+00
  xmin map   = -1.2500E-01
  xmax map   =  1.2500E-01
  ymin map   = -1.2500E-01
  ymax map   =  1.2500E-01

 plotype   =           2
 VPNX     CHANGED TO   0.0000E+00
  VPNY       =  0.0000E+00
```

```
VPNZ     CHANGED TO   1.0000E+00
 VRCX       =  0.0000E+00
 VRCY       =  0.0000E+00
 VRCZ       =  0.0000E+00
 VUPX       =  0.0000E+00
 VUPY       =  1.0000E+00
 VUPZ       =  0.0000E+00
 xmin map   = -1.2500E-01
 xmax map   =  1.2500E-01
 ymin map   = -1.2500E-01
 ymax map   =  1.2500E-01

plotype   =           2
   Elapse time so far =  3.6400E+00 secs:-
   user =  3.3700E+00 secs
   system =  1.3200E+00 secs
```

g_mtest

Mesh assembly test

central cylinder + 6 outer segments

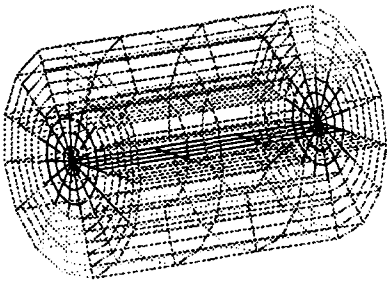
cylindrical local coords

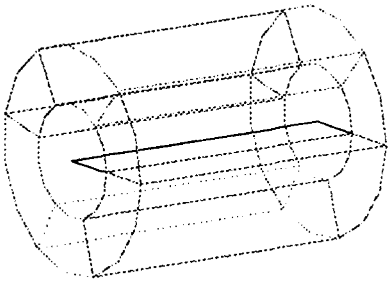
J W Eastwood

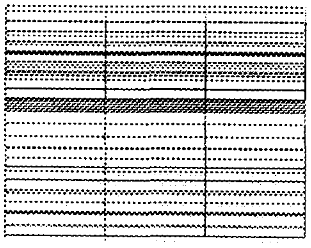
Date: 16-09-94

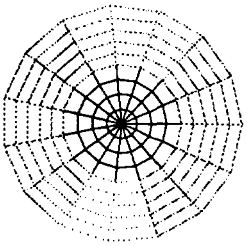
Time: 11:31:19

Ref: mtest









H EMBLK unit test data

```
rfesunh% xtest

 ?? DIR=1, 2, or 3?
1
 IDIR =  1

     LBLAS(I):
    24    16     8     1    25   425  3825     0    30     0

  N1=  24 N2=  16 N3=  8
  INC1=  1 INC2=  25 INC3=  425
  IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651

 DATA() Values as set

     DATA:
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
   2.0600E+02   6.7748E+01   2.0854E+02   3.0735E+01   2.1039E+02   9.3786E-01
   2.1200E+02  -2.6972E+01   2.1361E+02  -5.7078E+01   2.1546E+02  -9.4925E+01
   2.1800E+02  -1.5284E+02   2.2239E+02  -2.7473E+02   2.3439E+02  -8.7585E+02
   2.7560E+03


 ICOMP=  1
 IZ=  0
 IY=  0

     Initial data (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
 IY=  1

     Initial data (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
 IZ=  1
 IY=  0

     Initial data (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
 IY=  1

     Initial data (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02

 ICOMP=  2
 IZ=  0
 IY=  0

     Initial data (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
 IY=  1

     Initial data (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
 IZ=  1
 IY=  0

     Initial data (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
 IY=  1

     Initial data (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02

 ICOMP=  3
 IZ=  0
 IY=  0

     Initial data (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
 IY=  1

     Initial data (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
 IZ=  1
 IY=  0

     Initial data (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
```

```
IY=  1

    Initial data (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
DATA() Before analysis

    DATA:
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
  2.0600E+02   6.7748E+01   2.0854E+02   3.0735E+01   2.1039E+02   9.3786E-01
  2.1200E+02  -2.6972E+01   2.1361E+02  -5.7078E+01   2.1546E+02  -9.4925E+01
  2.1800E+02  -1.5284E+02   2.2239E+02  -2.7473E+02   2.3439E+02  -8.7585E+02
  2.7560E+03

 IDIR=  1 Just before first CALL VECFFT
 Just after analysis
 IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651
 IDIR=  1 Just after first CALL VECFFT

DATA() After analysis

    DATA:
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
  2.0600E+02   6.7748E+01   2.0854E+02   3.0735E+01   2.1039E+02   9.3786E-01
  2.1200E+02  -2.6972E+01   2.1361E+02  -5.7078E+01   2.1546E+02  -9.4925E+01
  2.1800E+02  -1.5284E+02   2.2239E+02  -2.7473E+02   2.3439E+02  -8.7585E+02
  2.7560E+03

ICOMP=  1
IZ=  0
IY=  0

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02
IY=  1

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02
IZ=  1
IY=  0

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02
IY=  1

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02

ICOMP=  2
IZ=  0
IY=  0

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02
IY=  1

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02
IZ=  1
IY=  0

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02
IY=  1

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02

ICOMP=  3
IZ=  0
IY=  0

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02
IY=  1

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02
IZ=  1
```

```
IY=  0

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02
IY=  1

    A(I) after anal (first six):
  2.0000E+02   1.0100E+02  -5.0500E+01   1.0200E+02  -5.1000E+01   1.0300E+02

 IDIR=  1 Just before second CALL VECFFT
 Just after synthesis
 IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651

DATA() After synthesis

    DATA:
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
  2.0600E+02   6.7748E+01   2.0854E+02   3.0735E+01   2.1039E+02   9.3786E-01
  2.1200E+02  -2.6972E+01   2.1361E+02  -5.7078E+01   2.1546E+02  -9.4925E+01
  2.1800E+02  -1.5284E+02   2.2239E+02  -2.7473E+02   2.3439E+02  -8.7585E+02
  2.7560E+03

ICOMP=  1
IZ=  0
IY=  0

    A(I) after anal+sync (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
IY=  1

    A(I) after anal+sync (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
IZ=  1
IY=  0

    A(I) after anal+sync (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
IY=  1

    A(I) after anal+sync (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02

ICOMP=  2
IZ=  0
IY=  0

    A(I) after anal+sync (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
IY=  1

    A(I) after anal+sync (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
IZ=  1
IY=  0

    A(I) after anal+sync (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
IY=  1

    A(I) after anal+sync (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02

ICOMP=  3
IZ=  0
IY=  0

    A(I) after anal+sync (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
IY=  1

    A(I) after anal+sync (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
IZ=  1
IY=  0

    A(I) after anal+sync (first six):
  2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
IY=  1
```

```
     A(I) after anal+sync (first six):
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
  Just after DO 40 loop
  IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651

 DATA() just before error check loop

     DATA:
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
   2.0600E+02   6.7748E+01   2.0854E+02   3.0735E+01   2.1039E+02   9.3786E-01
   2.1200E+02  -2.6972E+01   2.1361E+02  -5.7078E+01   2.1546E+02  -9.4925E+01
   2.1800E+02  -1.5284E+02   2.2239E+02  -2.7473E+02   2.3439E+02  -8.7585E+02
   2.7560E+03

  INC1=  1 INC2=  25 INC3=  425
  IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651
  INDEX=  1 A(INDEX)=    2756.00 DATA(IX)=    2756.00
  INDEX=  3826 A(INDEX)=    2756.00 DATA(IX)=    2756.00
  INDEX=  7651 A(INDEX)=    2756.00 DATA(IX)=    2756.00

     DATA:
   2.7560E+03   7.3445E+02   1.8961E+02   2.3708E+02   2.0161E+02   1.2344E+02
   2.0600E+02   6.7748E+01   2.0854E+02   3.0735E+01   2.1039E+02   9.3786E-01
   2.1200E+02  -2.6972E+01   2.1361E+02  -5.7078E+01   2.1546E+02  -9.4925E+01
   2.1800E+02  -1.5284E+02   2.2239E+02  -2.7473E+02   2.3439E+02  -8.7585E+02
   2.7560E+03

  ---------------------------------------------------
  ---------------- FINAL SUMMARY --------------------
  ---------------------------------------------------

 Backtransform equals original data

     ICOUNT, ICOMP, IX,    IY and IZ at maximum error:
      0      0      0      0      0

 CPU time for FFT routine
 Temperton FFT77 (anal + syn)/2 =  1.333333E-02  secs

  ---------------------------------------------------
rfesunh% xtest

 ?? DIR=1, 2, or 3?
2
 IDIR =  2

     LBLAS(I):
    24    16     8     1    25   425  3825     0    30     0

  N1=  24 N2=  16 N3=  8
  INC1=  1 INC2=  25 INC3=  425
  IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651

 DATA() Values as set

     DATA:
   1.8720E+03   4.8857E+02   1.9834E+02   1.4441E+02   2.0400E+02   6.0044E+01
   2.0634E+02   1.1647E+01   2.0800E+02  -2.9726E+01   2.0966E+02  -7.8937E+01
   2.1200E+02  -1.6689E+02   2.1766E+02  -5.5712E+02   1.8720E+03


 ICOMP=  1
 IZ=  0
 IY=  0

     Initial data (first six):
   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
 IY=  1

     Initial data (first six):
   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02
 IZ=  1
 IY=  0

     Initial data (first six):
   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
 IY=  1
```

```
    Initial data (first six):
  4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02

ICOMP=  2
IZ=  0
IY=  0

    Initial data (first six):
  1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
IY=  1

    Initial data (first six):
  4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02
IZ=  1
IY=  0

    Initial data (first six):
  1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
IY=  1

    Initial data (first six):
  4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02

ICOMP=  3
IZ=  0
IY=  0

    Initial data (first six):
  1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
IY=  1

    Initial data (first six):
  4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02
IZ=  1
IY=  0

    Initial data (first six):
  1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
IY=  1

    Initial data (first six):
  4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02
DATA() Before analysis

    DATA:
  1.8720E+03   4.8857E+02   1.9834E+02   1.4441E+02   2.0400E+02   6.0044E+01
  2.0634E+02   1.1647E+01   2.0800E+02  -2.9726E+01   2.0966E+02  -7.8937E+01
  2.1200E+02  -1.6689E+02   2.1766E+02  -5.5712E+02   1.8720E+03

 IDIR=  2 Just before first CALL VECFFT
 Just after analysis
 IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651
 IDIR=  2 Just after first CALL VECFFT

DATA() After analysis

    DATA:
  1.8720E+03   4.8857E+02   1.9834E+02   1.4441E+02   2.0400E+02   6.0044E+01
  2.0634E+02   1.1647E+01   2.0800E+02  -2.9726E+01   2.0966E+02  -7.8937E+01
  2.1200E+02  -1.6689E+02   2.1766E+02  -5.5712E+02   1.8720E+03

ICOMP=  1
IZ=  0
IY=  0

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IY=  1

    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02
IZ=  1
IY=  0

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IY=  1
```

```
    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02

ICOMP=  2
IZ=  0
IY=  0

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IY=  1

    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02
IZ=  1
IY=  0

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IY=  1

    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02

ICOMP=  3
IZ=  0
IY=  0

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IY=  1

    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02
IZ=  1
IY=  0

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IY=  1

    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02

 IDIR=  2 Just before second CALL VECFFT
 Just after synthesis
 IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651

DATA() After synthesis

    DATA:
  1.8720E+03   4.8857E+02   1.9834E+02   1.4441E+02   2.0400E+02   6.0044E+01
  2.0634E+02   1.1647E+01   2.0800E+02  -2.9726E+01   2.0966E+02  -7.8937E+01
  2.1200E+02  -1.6689E+02   2.1766E+02  -5.5712E+02   1.8720E+03

ICOMP=  1
IZ=  0
IY=  0

    A(I) after anal+sync (first six):
  1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
IY=  1

    A(I) after anal+sync (first six):
  4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02
IZ=  1
IY=  0

    A(I) after anal+sync (first six):
  1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
IY=  1

    A(I) after anal+sync (first six):
  4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02

ICOMP=  2
IZ=  0
IY=  0
```

```
     A(I) after anal+sync (first six):
   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
 IY=  1

     A(I) after anal+sync (first six):
   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02
 IZ=  1
 IY=  0

     A(I) after anal+sync (first six):
   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
 IY=  1

     A(I) after anal+sync (first six):
   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02

 ICOMP=  3
 IZ=  0
 IY=  0

     A(I) after anal+sync (first six):
   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
 IY=  1

     A(I) after anal+sync (first six):
   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02
 IZ=  1
 IY=  0

     A(I) after anal+sync (first six):
   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03   1.8720E+03
 IY=  1

     A(I) after anal+sync (first six):
   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02   4.8857E+02
  Just after DO 40 loop
  IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651

 DATA() just before error check loop

     DATA:
   1.8720E+03   4.8857E+02   1.9834E+02   1.4441E+02   2.0400E+02   6.0044E+01
   2.0634E+02   1.1647E+01   2.0800E+02  -2.9726E+01   2.0966E+02  -7.8937E+01
   2.1200E+02  -1.6689E+02   2.1766E+02  -5.5712E+02   1.8720E+03

  INC1=  1 INC2=  25 INC3=  425
  IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651
  INDEX=  1 A(INDEX)=     1872.00 DATA(IX)=    1872.00
  INDEX=  3826 A(INDEX)=     1872.00 DATA(IX)=    1872.00
  INDEX=  7651 A(INDEX)=     1872.00 DATA(IX)=    1872.00

     DATA:
   1.8720E+03   4.8857E+02   1.9834E+02   1.4441E+02   2.0400E+02   6.0044E+01
   2.0634E+02   1.1647E+01   2.0800E+02  -2.9726E+01   2.0966E+02  -7.8937E+01
   2.1200E+02  -1.6689E+02   2.1766E+02  -5.5712E+02   1.8720E+03

  ---------------------------------------------------
  ---------------- FINAL SUMMARY --------------------
  ---------------------------------------------------

 Backtransform equals original data

     ICOUNT, ICOMP, IX,     IY and IZ at maximum error:
      0      0      0      0      0

 CPU time for FFT routine
 Temperton FFT77 (anal + syn)/2 =  1.104167E-02  secs

  ---------------------------------------------------
rfesunh% xtest

 ?? DIR=1, 2, or 3?
3
 IDIR =  3

     LBLAS(I):
    24    16     8     1    25   425  3825     0    30     0
 N1=  24 N2=  16 N3=  8
 INC1=  1 INC2=  25 INC3=  425
 IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651

DATA() Values as set

    DATA:
  1.0200E+03   2.3542E+02   2.0200E+02   3.7078E+01   2.0400E+02  -4.7421E+01
  2.0600E+02  -2.5708E+02   1.0200E+03


ICOMP=  1
IZ=  0
IY=  0

    Initial data (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IY=  1

    Initial data (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IZ=  1
IY=  0

    Initial data (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02
IY=  1

    Initial data (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02

ICOMP=  2
IZ=  0
IY=  0

    Initial data (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IY=  1

    Initial data (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IZ=  1
IY=  0

    Initial data (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02
IY=  1

    Initial data (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02

ICOMP=  3
IZ=  0
IY=  0

    Initial data (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IY=  1

    Initial data (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IZ=  1
IY=  0

    Initial data (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02
IY=  1

    Initial data (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02
DATA() Before analysis

    DATA:
  1.0200E+03   2.3542E+02   2.0200E+02   3.7078E+01   2.0400E+02  -4.7421E+01
  2.0600E+02  -2.5708E+02   1.0200E+03

 IDIR=  3 Just before first CALL VECFFT
 Just after analysis
 IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651
 IDIR=  3 Just after first CALL VECFFT

DATA() After analysis

    DATA:
  1.0200E+03   2.3542E+02   2.0200E+02   3.7078E+01   2.0400E+02  -4.7421E+01
  2.0600E+02  -2.5708E+02   1.0200E+03

ICOMP=  1
IZ=  0
IY=  0

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IY=  1

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IZ=  1
IY=  0

    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02
IY=  1

    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02

ICOMP=  2
IZ=  0
IY=  0

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IY=  1

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IZ=  1
IY=  0

    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02
IY=  1

    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02

ICOMP=  3
IZ=  0
IY=  0

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IY=  1

    A(I) after anal (first six):
  2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02   2.0000E+02
IZ=  1
IY=  0

    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02
IY=  1

    A(I) after anal (first six):
  1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02   1.0100E+02

 IDIR=  3 Just before second CALL VECFFT
 Just after synthesis
 IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651

DATA() After synthesis

    DATA:
  1.0200E+03   2.3542E+02   2.0200E+02   3.7078E+01   2.0400E+02  -4.7421E+01
  2.0600E+02  -2.5708E+02   1.0200E+03

ICOMP=  1
IZ=  0
IY=  0

    A(I) after anal+sync (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IY=  1

    A(I) after anal+sync (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IZ=  1
IY=  0

    A(I) after anal+sync (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02
IY=  1

    A(I) after anal+sync (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02

ICOMP=  2
IZ=  0
IY=  0

    A(I) after anal+sync (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IY=  1

    A(I) after anal+sync (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IZ=  1
IY=  0

    A(I) after anal+sync (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02
IY=  1

    A(I) after anal+sync (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02

ICOMP=  3
IZ=  0
IY=  0

    A(I) after anal+sync (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IY=  1

    A(I) after anal+sync (first six):
  1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03   1.0200E+03
IZ=  1
IY=  0

    A(I) after anal+sync (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02
IY=  1

    A(I) after anal+sync (first six):
  2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02   2.3542E+02
 Just after DO 40 loop
 IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651

DATA() just before error check loop

    DATA:
  1.0200E+03   2.3542E+02   2.0200E+02   3.7078E+01   2.0400E+02  -4.7421E+01
  2.0600E+02  -2.5708E+02   1.0200E+03

 INC1=  1 INC2=  25 INC3=  425
 IOR(1)=  1 IOR(2)=  3826 IOR(3)=  7651
 INDEX=  1 A(INDEX)=    1020.00 DATA(IX)=    1020.00
 INDEX=  3826 A(INDEX)=    1020.00 DATA(IX)=    1020.00
 INDEX=  7651 A(INDEX)=    1020.00 DATA(IX)=    1020.00

    DATA:
  1.0200E+03   2.3542E+02   2.0200E+02   3.7078E+01   2.0400E+02  -4.7421E+01
```

```
      2.0600E+02  -2.5708E+02   1.0200E+03

     ---------------------------------------------------
     ---------------- FINAL SUMMARY --------------------
     ---------------------------------------------------

    Backtransform equals original data

        ICOUNT, ICOMP, IX,    IY and IZ at maximum error:
         0       0      0      0      0

    CPU time for FFT routine
    Temperton FFT77 (anal + syn)/2 =  1.166667E-02  secs

     ---------------------------------------------------
```

```
rfesunh% cd TEST1
rfesunh% xtest
 Test 1: influences from padding layer
 maximum error:   0.

 Test 2: curl grad x = 0
 maximum error:     5.96046E-08

 Test 3: curl (w x r)  = 2 w
 maximum error:   0.

rfesunh% cd ../TEST2
rfesunh% xtest
 Test 1: influences from padding layer
 maximum error:   0.

 Test 2: curl grad x = 0
 maximum error:     5.96046E-08

 Test 3: curl (w x r)  = 2 w
 maximum error:   0.

 Test 4: current preserved
 maximum error:   0.

rfesunh% cd ../TEST5
rfesunh% xtest
 Test 1: influences from padding layer
 maximum error:   0.

 Test 2: curl grad x = 0
 maximum error:     1.49012E-08

 Test 3: curl (w x r)  = 2 w
 maximum error:   0.

 Test 4: current preserved
 maximum error:   0.

rfesunh%
```

I PEGGIE test data examples

```
o_mug2
'NLRES  L  False for NEWRUN,True for RESET' F
mug2
CHLAB1    replace these four lines
CHLAB2    by run labelling information
CHLAB3    which will appear at the start
CHLAB4    of the NOUT channel output
'CHLAB5   A  **Label available to programmer            1.1 ' /
'NDIARY   I  **Channel for diary                        1.2 ' /
'NIN      I  **Current input channel                    1.2 ' /
'NLEDGE   I  **Channel for restart records              1.2 ' /
'NONLIN   I  **Channel for input-output                 1.2 ' /
'NOUT     I  **Current output channel                   1.2 ' /
'NPRINT   I  **Channel for printed output               1.2 ' /
'NPUNCH   I  **Channel for card output (or equivalent)  1.2 ' /
'NREC     I  **Current record number                    1.2 ' /
'NRUN     I  **Maximum number of steps                  1.2 ' /
'NADUMP   IA **Codes for array dumps                    1.9 ' /
'NPDUMP   IA **Codes for dumping points                 1.9 ' /
'NVDUMP   IA **Codes for dumping arrays                 1.9 ' /
'NLCHED   L  **.TRUE. if class 0 report-head required   1.9 ' /
'NLHEAD   LA **.TRUE. if class 1-9 report-heads required 1.9 ' /
'NLOMT1   LA **Class 1 subprogram selector              1.9 ' /
'NLOMT2   LA **Class 2 subprogram selector              1.9 ' /
'NLOMT3   LA **Class 3 subprogram selector              1.9 ' /
'NLREPT   L  **.TRUE. if report required                1.9 ' /
BL inset part2 uniform1
BL sides annulu uniform1
BL bottom disc uniform1
BL handle ubend uniform1
BG part2 polar_to_rectangular_transition -6  -10 -16
&POLRCT RADCUR=4.,RADSTR=5.,THEMIN=30.,THEMAX=90.,AXMIN=0.,AXMAX=8./
BG annulu polar_with_regular_meshing -6  -50 -16
&POLREG RADINR=4.,RADOUT=5.,THEMAX=300.,AXMAX=8./
BG disc polar_with_regular_meshing -6  -40 -16
&POLREG RADINR=0.,RADOUT=4.,THEMAX=360.,AXMAX=1./
BG ubend polar_with_regular_meshing -1 -10 -1
&POLREG RADINR=1.,RADOUT=2.,THEMAX=180.,AXMAX=1./
BP uniform1 uniform
&UNIFRM EPSR=1.,RMUR=1./
PP pcond pcond
PA pcond sameas pcond
BC inset
W(0,0)(1,0.125)=bottom:E(0.,0.)(0.16666667,1.0)
W(0,0.125)(1,1)=pcond
S=sides:N
N=sides:S
E(0.4,0.75)(0.6,0.875)=handle:N(0,1)(1,0)
E(0.4,0.375)(0.6,0.5)=handle:S(1,1)(0,0)
E(0.,0.)(0.4,1.0)=pcond
E(0.6,0.)(1.0,1.0)=pcond
E(0.4,0.)(0.6,0.375)=pcond
E(0.4,0.5)(0.6,0.75)=pcond
E(0.4,0.875)(0.6,1.0)=pcond
U=pcond
Down =pcond
EN
BC handle
W=pcond
S(1,1)(0,0)=inset:E(0.4,0.375)(0.6,0.5)
N(0,1)(1,0)=inset:E(0.4,0.75)(0.6,0.875)
E=pcond
U=pcond
D=pcond
EN
BC sides
W(0,0)(1,0.125)=bottom:E(0.16666667,0)(1,1)
W(0,0.125)(1,1)=pcond
S=inset:N
N=inset:S
E=pcond
U=pcond
Down =pcond
EN
BC bottom
W=pcond
S=pcond
N=pcond
```

```
E(0.,0.)(0.16666667,1.0)=inset:W(0,0)(1,0.125)
E(0.16666667,0)(1,1)=sides:W(0,0)(1,0.125)
U=pcond
Down =pcond
EN
SF origin
OR handle inset sides bottom
```

```
o_tl30
'NLRES  L  False for NEWRUN,True for RESET' F
tl30
CHLAB1    replace these four lines
CHLAB2    by run labelling information
CHLAB3    which will appear at the start
CHLAB4    of the NOUT channel output
'CHLAB5   A  **Label available to programmer          1.1 ' /
'NDIARY   I  **Channel for diary                      1.2 ' /
'NIN      I  **Current input channel                  1.2 ' /
'NLEDGE   I  **Channel for restart records            1.2 ' /
'NONLIN   I  **Channel for input-output               1.2 ' /
'NOUT     I  **Current output channel                 1.2 ' /
'NPRINT   I  **Channel for printed output             1.2 ' /
'NPUNCH   I  **Channel for card output (or equivalent)  1.2 ' /
'NREC     I  **Current record number                  1.2 ' /
'NRUN     I  **Maximum number of steps                1.2 ' /
'NADUMP   IA **Codes for array dumps                  1.9 ' /
'NPDUMP   IA **Codes for dumping points               1.9 ' /
'NVDUMP   IA **Codes for dumping arrays               1.9 ' /
'NLCHED   L  **.TRUE. if class 0 report-head required    1.9 ' /
'NLHEAD   LA **.TRUE. if class 1-9 report-heads required 1.9 ' /
'NLOMT1   LA **Class 1 subprogram selector            1.9 ' /
'NLOMT2   LA **Class 2 subprogram selector            1.9 ' /
'NLOMT3   LA **Class 3 subprogram selector            1.9 ' /
'NLREPT   L  **.TRUE. if report required              1.9 ' /
SF courant number
&SF DTMUL=0.4,NRUN=125,
NDSPS=1,2,
NFSPS=1,2,
NPS=2,
NTSPS=1,2,
CFMTPS='grl','grl',
MFLFS=3,1,
NFLFS=1,2,3,0,0,0,0,0,0,0,4,
NFS=2,
NPSFS=1,2,
MDODS=1,1,
NDODS=1,0,0,0,0,0,0,0,0,0,2,
NDS=2,
NPSDS=1,2,
TIMETS=0.,0.20000000E-10,0.15000000E-11,0.,0.,0.10000000E+10,0.,0.20000000E-10,0.15000000E-11,0.,0.,0.10000000E
NPSTS=1,2,
NTS=2,
CNLTIM='Time','Time',
CNSTIM='t','t',
CNUFRQ='GHz','GHz',
CNUTIM='ns','ns',
CNURAT='/ns','/ns',
SLIMDO=0.,0.20000001E+02,0.,0.20000001E+02,
MSUDO=8,2,
NCOLDO=1,1,
NDO=2,
NDSDO=1,2,
NSUDO=1,2,3,4,6,7,8,9,0,0,5,10,
CNLDO='axial distance (m)','axial distance (m)',
CNSDO='z (m)','z (m)',
FLIMFL=-10.0000000,10.0000000,-10.0000000,10.0000000,-10.0000000,10.0000000,0.,20.0000000,
SCLFL=0.,0.,0.,0.,0.,-1.0000000,
NCOLFL=2,3,4,2,
NFL=4,
NFSFL=1,1,1,2,
CFLSPC='int D.dS','int B.dS','int j.dS','int E.dl',
CNLFL='total displacement current','total magnetic flux','total electron current','radial voltage',
CNSFL='Id','phi','Ie','Vr',
CNUFL='A','Tm2','A','V',
NPSU=1,1,1,1,5,6,6,6,6,10,
NSU=10,
NSUBLK=1,2,3,4,2,5,6,7,8,6,
NSUD=1,2,3,1,2,3,1,2,3,1,2,3,1,2,3,1,2,3,1,2,3,1,2,3,1,2,3,1,2,3,
NSUDOM=1,1,1,1,2,1,1,1,1,2,
NSUDS=1,1,1,1,2,1,1,1,1,2,
NSUFS=1,1,1,1,2,1,1,1,1,2,
NSUO=0,0,0,0,0,0,0,0,0,0,0,0,0,3,0,0,0,0,0,0,0,0,0,0,0,0,0,0,3,
NSUPS=1,1,1,1,2,1,1,1,1,2,
NSUTS=1,1,1,1,2,1,1,1,1,2,
NSUX=4,23,9,4,7,9,4,7,9,4,7,9,4,3,9,4,23,9,4,7,9,4,7,9,4,7,9,4,3,9,
NXTPSU=6,0,0,0,10/
```

```
BG centre polar_with_regular_meshing  -5 -24 -10
&POLREG RADINR=0.,RADOUT=0.0005,THEMAX=360.,AXMAX=0.001/
BG outer polar_with_regular_meshing -5 -8 -10
&POLREG RADINR=0.0005,RADOUT=0.001,THEMAX=120.,AXMAX=0.001/
BP uniform1 uniform
&UNIFRM EPSR=1.,RMUR=1./
BP uniform2 uniform
&UNIFRM /
BL b1 centre uniform1
BL b1a sameas b1
BL b2 outer uniform1
BL b3 sameas b2
BL b4 sameas b2
BL b2a sameas b3
BL b3a sameas b2
BL b4a sameas b3
PP pcond perfect_conductor
&BCS /
PP reswal resistive_wall
&BCS SURFZ=377.,STHETA=0.5 /
PP aplfld applied_field
&BCS DAPLYA(1)=115.5712,DAPLYA(2)=0.,DAPLYA(3)=0. /
PP axis polar_axis
&BCS /
PA pcond sameas pcond
PA reswal sameas reswal
PA aplfld sameas aplfld
PA axis sameas axis
BC b2
W= b1:E (0, 0)(0.333333,1)
N=b3:S
S=b4:N
E=pcond
D=aplfld
Up = b2a:D
EN
BC b3
W=b1:E(0.333333,0)(0.666667,1)
N=b4:S
S=b2:N
E=pcond
D=aplfld
U=b3a:D
EN
BC b4
W=b1:E(0.666667,0)(1.,1)
N=b2:S
S=b3:N
E=pcond
D=aplfld
U=b4a:D
EN
BC b1
E(0,0)(0.333333,1)=b2:W
E(0.333333,0)(0.666667,1)=b3:W
E(0.666667,0)(1.,1)=b4:W
D=aplfld
U(1,0)(0,1)=b1a:D(1,0)(0,1)
S=b1:N
N=b1:S
W=axis
EN
BC b2a
W= b1a:E (0, 0)(0.333333,1)
N=b3a:S
S=b4a:N
E=pcond
D=b2:U
Up = reswal
EN
BC b3a
W=b1a:E(0.333333,0)(0.666667,1)
N=b4a:S
S=b2a:N
E=pcond
D=b3:U
U=reswal
EN
```

```
BC b4a
W=b1a:E(0.666667,0)(1.,1)
N=b2a:S
S=b3a:N
E=pcond
D=b4:U
U=reswal
EN
BC b1a
E(0,0)(0.333333,1)=b2a:W
E(0.333333,0)(0.666667,1)=b3a:W
E(0.666667,0)(1.,1)=b4a:W
D(1,0)(0,1)=b1:U(1,0)(0,1)
U=reswal
S=b1a:N
N=b1a:S
W=axis
EN
OR b1 b2 b3 b4 b1a b2a b3a b4a
```

```
o_uni20
'NLRES  L  False for NEWRUN,True for RESET' F
uni20
Uniform B test
CHLAB2     by run labelling information
CHLAB3     which will appear at the start
CHLAB4     of the NOUT channel output
'CHLAB5    A  **Label available to programmer         1.1 ' /
'NDIARY    I  **Channel for diary                     1.2 ' /
'NIN       I  **Current input channel                 1.2 ' /
'NLEDGE    I  **Channel for restart records           1.2 ' /
'NONLIN    I  **Channel for input-output              1.2 ' /
'NOUT      I  **Current output channel                1.2 ' /
'NPRINT    I  **Channel for printed output            1.2 ' /
'NPUNCH    I  **Channel for card output (or equivalent)  1.2 ' /
'NREC      I  **Current record number                 1.2 ' /
'NRUN      I  **Maximum number of steps               1.2 ' /
'NADUMP    IA **Codes for array dumps                 1.9 ' /
'NPDUMP    IA **Codes for dumping points              1.9 ' /
'NVDUMP    IA **Codes for dumping arrays              1.9 ' /
'NLCHED    L  **.TRUE. if class 0 report-head required    1.9 ' /
'NLHEAD    LA **.TRUE. if class 1-9 report-heads required 1.9 ' /
'NLOMT1    LA **Class 1 subprogram selector           1.9 ' /
'NLOMT2    LA **Class 2 subprogram selector           1.9 ' /
'NLOMT3    LA **Class 3 subprogram selector           1.9 ' /
'NLREPT    L  **.TRUE. if report required             1.9 ' /
SF courant_number
&SF DTMUL=0.4,
NINIT=1,
MDPART=1,
NRUN=50,
NXPTDD=7,
BUNI(3)=1./
BG type1 quadrilateral_cylinder  -3 -4 -5
&QUADRI XQUAD1=0.,YQUAD1=0.4,XQUAD2=0.5,YQUAD2=0.5,RXMAX=0.3,RZMAX=1.0/
BG type2 quadrilateral_cylinder -3 -4 -5
&QUADRI XQUAD1=0.2,YQUAD1=0.5,XQUAD2=0.7,YQUAD2=0.6,RXMAX=0.7,RZMAX=1.0/
BG type1r quadrilateral_cylinder -3 -4 -5
&QUADRI XQUAD1=0.2,YQUAD1=0.5,XQUAD2=0.5,YQUAD2=0.5,RXMAX=0.5,RYMAX=0.1,RZMAX=1.0/
BG type2r quadrilateral_cylinder  -3 -4 -5
&QUADRI XQUAD1=0.,YQUAD1=0.6,XQUAD2=0.7,YQUAD2=0.6,RXMAX=0.5,RYMAX=0.1,RZMAX=1.0/
BP uniform1 uniform
&UNIFRM EPSR=1.,RMUR=1./
BP uniform2 uniform
&UNIFRM /
BL b1 type1 uniform1
BL b2 type2 uniform1
BL b3 type1r uniform1
BL b4 type2r uniform1
BL b1a sameas b1
BL b2a sameas b2
BL b3a sameas b3
BL b4a sameas b4
PP pcond perfect_conductor
PP reswal resistive_wall
&BCS SURFZ=377.,STHETA=0.5 /
PP aplfld applied_field
&BCS DAPLYA(1)=115.5712,DAPLYA(2)=0.,DAPLYA(3)=0. /
PA pcond sameas pcond
PA reswal sameas reswal
PA aplfld sameas aplfld
BC b1
E=b2:W
D=b1a:U
U=b1a:D
S=pcond
N=b4:S
W=pcond
EN
BC b2
W=b1:E
N=b3:S
S=pcond
E=pcond
D=b2a:U
U=b2a:D
EN
BC b3
```

```
W=b4:E
S=b2:N
N=pcond
E=pcond
D=b3a:U
U=b3a:D
EN
BC b4
W=pcond
S=b1:N
N=pcond
E=b3:W
D=b4a:U
U=b4a:D
EN
BC b1a
E=b2a:W
D=b1:U
U=b1:D
S=pcond
N=b4a:S
W=pcond
EN
BC b2a
W=b1a:E
N=b3a:S
S=pcond
E=pcond
D=b2:U
U=b2:D
EN
BC b3a
W=b4a:E
S=b2a:N
N=pcond
E=pcond
D=b3:U
U=b3:D
EN
BC b4a
W=pcond
S=b1a:N
N=pcond
E=b3a:W
D=b4:U
U=b4:D
EN
OR b1 b2 b3 b4 b1a b2a b3a b4a
```

```
uni20.out
'NLRES    L ' /

Uniform B test
CHLAB2    by run labelling information
CHLAB3    which will appear at the start
CHLAB4    of the NOUT channel output
'CHLAB5   A ' /
'NDIARY   I '       7
'NIN      I '       1
'NLEDGE   I '       8
'NONLIN   I '       6
'NOUT     I '       2
'NPRINT   I '       2
'NPUNCH   I '       7
'NREC     I '       1
'NRUN     I '     100
'NADUMP   IA' /
'NPDUMP   IA' /
'NVDUMP   IA' /
'NLCHED   L ' /
'NLHEAD   LA' /
'NLOMT1   LA' /
'NLOMT2   LA' /
'NLOMT3   LA' /
'NLREPT   L ' /
'COUR     R ' /
'DT       R '   0.17781136E-09
'SCALE    RA'
   0.53343408E-01   0.17781136E-09   0.30000000E+09    19184578.
   0.63948594E-01   0.53343408E-01   18.746458         376.99115
   0.18196694E-03   0.48268231E-06   0.18196694E-03   0.48268231E-06
   0.48268231E-06    953982.38       0.48268231E-06   0.26525822E-02
    54590.086        376.99115    /
'NSUBS    I '       1
'ROTG2L   RA'
    1.0000000              0.              0.
           0.       1.0000000              0.
           0.              0.       1.0000000
    1.0000000              0.              0.
   0.25691664E-07   1.0000000              0.
           0.              0.       1.0000000
   0.99999988      -0.37252909E-06         0.
   0.37252909E-06   0.99999988             0.
           0.              0.       0.99999988
    1.0000000       0.14328044E-07         0.
           0.       1.0000000              0.
           0.              0.       1.0000000
    1.0000000              0.              0.
           0.       0.99999994             0.
           0.              0.       1.0000000
    1.0000000      -0.25691664E-07         0.
           0.       1.0000000              0.
           0.              0.       1.0000000
    1.0000001      -0.36971241E-06         0.
```

```
  0.38731775E-06    1.0000001             0.
          0.              0.        1.0000002
   1.0000000              0.              0.
 -0.14328043E-07    1.0000000             0.
          0.              0.        1.0000000    /
'XYZBLK   RA'
          0.              0.              0.
   5.6239371              0.              0.
          0.        7.4985828             0.
          0.              0.        18.746456
   9.3732281        9.3732281             0.
   5.6239371              0.        18.746456
          0.        7.4985828       18.746456
   9.3732281        9.3732281       18.746456
   5.6239371              0.              0.
   18.746456      0.33713937E-06          0.
   9.3732281        9.3732281             0.
   5.6239371              0.        18.746456
   18.746456        11.247877             0.
   18.746456      0.33713937E-06    18.746456
   9.3732281        9.3732281       18.746456
   18.746456        11.247877       18.746456
   9.3732281        9.3732281             0.
   18.746456        11.247877             0.
   13.122516        18.746458             0.
   9.3732281        9.3732281       18.746454
   18.746452        18.746460             0.
   18.746456        11.247877       18.746454
   13.122516        18.746458       18.746454
   18.746452        18.746460       18.746454
          0.        7.4985828             0.
   9.3732281        9.3732281             0.
  0.16116003E-06    18.746456             0.
          0.        7.4985828       18.746456
   13.122519        18.746456             0.
   9.3732281        9.3732281       18.746456
  0.16116003E-06    18.746456       18.746456
   13.122519        18.746456       18.746456
          0.              0.        18.746456
   5.6239371              0.        18.746456
          0.        7.4985824       18.746456
          0.              0.        37.492912
   9.3732281        9.3732281       18.746456
   5.6239371              0.        37.492912
          0.        7.4985824       37.492912
   9.3732281        9.3732281       37.492912
   5.6239371              0.        18.746456
   18.746456              0.        18.746456
   9.3732281        9.3732281       18.746456
   5.6239371              0.        37.492912
   18.746456        11.247877       18.746456
   18.746456              0.        37.492912
   9.3732281        9.3732281       37.492912
   18.746456        11.247877       37.492912
   9.3732281        9.3732281       18.746454
```

```
mug2.out
'NLRES     L ' /

CHLAB1     replace these four lines
CHLAB2     by run labelling information
CHLAB3     which will appear at the start
CHLAB4     of the NOUT channel output
'CHLAB5    A ' /
'NDIARY    I '          7
'NIN       I '          1
'NLEDGE    I '          8
'NONLIN    I '          6
'NOUT      I '          2
'NPRINT    I '          2
'NPUNCH    I '          7
'NREC      I '          1
'NRUN      I '          1
'NADUMP    IA' /
'NPDUMP    IA' /
'NVDUMP    IA' /
'NLCHED    L ' /
'NLHEAD    LA' /
'NLOMT1    LA' /
'NLOMT2    LA' /
'NLOMT3    LA' /
'NLREPT    L ' /
'COUR      R ' /
'DT        R '   0.18137993E-08
'SCALE     RA'
   0.54413980       0.18137993E-08   0.30000000E+09    1880713.0
   0.62690433E-02   0.54413980        1.8377630         376.99115
   0.18561893E-02   0.49236951E-05   0.18561893E-02   0.49236951E-05
   0.49236951E-05    9168.1328       0.49236951E-05   0.26525822E-02
    556856.81        376.99115    /
'NSUBS     I '          1
'ROTG2L    RA'
    1.0000000                0.               0.
           0.        1.0000000                0.
           0.               0.        1.0000000
  -0.16292046E-06  -0.28218699E-06   -1.0000000
   0.49999928       0.86602569      -0.32584137E-06
   0.86602569      -0.49999928              0.
  -0.28218699E-06   0.16292046E-06   -1.0000001
   0.86602569      -0.49999931      -0.32584143E-06
  -0.49999928      -0.86602575       0.14210851E-13
  -0.28218682E-06  -0.16292090E-06   -1.0000001
   0.86602515       0.50000066      -0.32584137E-06
   0.50000066      -0.86602509      -0.19897094E-13/
'XYZBLK    RA'
           0.               0.               0.
    1.8377630               0.               0.
   -3.6755259      -0.59881921E-06           0.
           0.               0.        1.8377630
   -5.5132890      -0.11976384E-05           0.
    1.8377630               0.        1.8377630
```

```
   -3.6755259      -0.59881921E-06    1.8377630
   -5.5132890      -0.11976384E-05    1.8377630
    7.3510518       -1.5915484        4.5944061
    7.3510513       0.98585292E-06    5.5132895
    7.3510518       -1.5915431       -2.7566452
   -7.3510509       -1.5915532        4.5944061
    7.3510513       0.74486661E-05   -3.6755254
   -7.3510518      -0.38338721E-05    5.5132895
   -7.3510509       -1.5915480       -2.7566452
   -7.3510518       0.26289410E-05   -3.6755254
    7.3510518       -1.5915431       -2.7566452
    7.3510513       0.67914307E-05   -3.6755254
    7.3510518       -1.5915613        4.5944276
   -7.3510537       -1.5915480       -2.7566452
    7.3510513      -0.15554568E-04    5.5133152
   -7.3510537       0.19717058E-05   -3.6755254
   -7.3510537       -1.5915661        4.5944276
   -7.3510537      -0.20374293E-04    5.5133152
    7.3510537       -7.9577441       0.91887534
    7.3510513       -1.5915482        4.5944061
    7.3510537       -7.9577441       0.91887534
    5.5132904       -7.9577446       0.91887534
    7.3510513       -1.5915653        4.5944352
    5.5132885       -1.5915486        4.5944061
    5.5132904       -7.9577446       0.91887534
    5.5132885       -1.5915657        4.5944352    /
'MBKPAT    IA'
       -6        -17        -22        -27/
'MBKTYP    IA'
        1          2          3          4/
'MEMBCA    IA' /
'MPABCA    IA' /
'MPATBK    IA'
        1          2
        1          2
        1          1
        1          1
        1          1
        1          1
        2          3
        2          3
        2          4
        2          2
        2          2
        2          2
        2          2
        2          2
        2          2
        2          2
        2          2
        3          4
        3          3
        3          3
        3          3
        3          3
        4        4
        4        4
        4        4
        4        4
        4        4/
'MPATO    IA'
    10001  6004006
  1000001  6004003
        0        0
        1        0
  1000000        0
        0        0
    10000        0
        0    50000
        0  6000000
        0        0
        8        0
  6004007        0
  6004004        0
  6004000        0
  6006000        0
  6000000        0
        1        0
        0  6010000
        0        0
        8        0
  6000000        0
        1        0
        0        0
        1        0
    60000/
'MPATX    IA'
  1010000  6006007
        0  6006004
  1010000 10001000
  1010001  1010000
  1010001 10001000
    10001  1010000
  6010008  6000008
  6000008  6050008
    10001  6010001
  6010000 10006000
  6010008  6010000
  6006008  2001000
  6006006  2002000
  6006003  2003000
  6010008  4008000
  6004008  4008000
    10008  7010000
    50001  6060001
  6050000 50006000
  6050008  6050000
  6050008 50008000
    50008  7050000
  6060000 60006000
```

```
  6060001  6060000
  6060001  1006000
  6000001  6001000
    60001  1060000/
'MPATYP   IA'
        1        1       -1       -1       -1       -1        1        1
        1       -1       -1       -1       -1       -1       -1       -1
       -1        1       -1       -1       -1       -1       -1       -1
       -1       -1       -1/
'NBLOCK   I '        4
'NPATCH   I '       27
'NXTPAT   IA'
        0        0
       -1        1
       -2        2
       -3        3
       -4        4
       -5        5
        2        0
       -7        7
       -8        0
       -9        9
      -10       10
      -11       11
      -12       12
      -13       13
      -14       14
      -15       15
      -16       16
        8        9
      -18       18
      -19        0
      -20       20
      -21       21
       18       22
      -23       23
      -24       24
      -25       25
      -26        0
       18       27
       23       28
       24       29
       25       30
       26       31
       27       32/
'LBLAS    IA'
        1       10        1        1        2       22       44        0
        3        2        0        0        6       10        8        1
        7       77      693        0       13        1        0        0
        6       50        8        1        7      357     3213        0
        3        2        0        0        6       60        1        1
        7      427      854        0        3        2       1/
'LECOVA   IA'
        0        0        0        2        0        0
        0        0        0        1        0        0
```

```
0    0    0    1    0    0
0    0    0    1    0    0
0    0    0    3    0    0
0    0    0    1    0    0
0    0    0    1    0    0
0    0    0    1    0    0
0    0    0    4    0    0
0    0    0    5    0    0
1    0    0    6    0    0
0    0    0    5    0    0
0    0    0    0    0    0
0    0    0    0    0    0
0    0    0    0    0    0
0    0    0    0    0    0
0    0    0    0    0    0
0    0    0    0    0    0
0    0    0    0    0    0
0    0    0    0    0    0
0    0    0    0    0    0
0    0    0    0    0    0
0    0    0    0    0    0
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0    0    0    0    0    0
0    0    0    0    0    0
0    1    0    2    0    0
0    1    0   13    0    0
0    0    0    1    0    0
1    7    0   24    0    0
1    7    0  101    0    0
0    0    0    1    0    0
0    0    0    1    0    0
0    0    0    1    0    0
0    0    0  178    0    0
0    0    0  179    0    0
0    0    0  180    0    0
0    0    0  181    0    0
0    0    0    0    0    0
0    0    0    0    0    0
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0 0 0 5 0 0
1 0 0 6 0 0
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0 0 0 0 0 0
0 0 0 2 0 0
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0 0 0 1 0 0
0 0 0 1 0 0
0 0 0 3 0 0
0 0 0 1 0 0
```

```
         0         0         0         1         0         0
         0         0         0         1         0         0
         0         0         0         4         0         0
         0         0         0         5         0         0
         1         0         0         6         0         0
         0         0         0         5/
'LGBHAD   IA'
         1         1         1         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0        10        12        14
         1         1         1        10        12        14         1
         1         1        10        12        14         1         1
         1        10        12        14         1         1         1
         0         0         0         0         0         0         0
         1         1         1         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0        10        12        14
        16        16        16        16        16        16        16
        16        16        16        16        16        16        16
        16        16        16        16        16        16        16
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
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         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         1         1         1         1         0         0         7
         7         7         7         0         0         0         0
         0         0         0         0       543       620       697
       233         1         1       543       620       697       310
         1         1       543       620       697       387         1
         1       543       620       697       464         1         1
```

```
         0         0         0         0         0         0         0
         1         1         1         1         0         0         7
         7         7         7         0         0         0         0
         0         0         0         0       543       620       697
       774       774       774       774       774       774       774
       774       774       774       774       774       774       774
       774       774       774       774       774       774       774
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         1         1         1         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0        25        32        39
         1         1         1        25        32        39         1
         1         1        25        32        39         1         1
         1        25        32        39         1         1         1
         0         0         0         0         0         0         0
         1         1         1         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0        25        32        39
        46        46        46        46        46        46        46
        46        46        46        46        46        46        46
        46        46        46        46        46        46        46
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
```

```
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     1      1      1      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0     25     32     39
     1      1      1     25     32     39      1
     1      1     25     32     39      1      1
     1     25     32     39      1      1      1
     0      0      0      0      0      0      0
     1      1      1      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0     25     32     39
    46     46     46     46     46     46     46
    46     46     46     46     46     46     46
    46     46     46     46     46     46     46
     0      0      0      0      0      0     .0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
```

```
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       1      1      1      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0     25     32     39
     879    879    879    879    879    879    879
     879    879    879    879    879    879    879
     879    879    879    879    879    879    879/
'LGDEAD   IA'
       1      1      1      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      2      4      6
       1      1      1      2      4      6      1
       1      1      2      4      6      1      1
       1      2      4      6      1      1      1
       0      0      0      0      0      0      0
       1      1      1      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      2      4      6
      16     16     16     16     16     16     16
      16     16     16     16     16     16     16
      16     16     16     16     16     16     16
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
       0      0      0      0      0      0      0
```

```
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  1     1     1     1     0     0     7
  7     7     7     0     0     0     0
  0     0     0     0     2    79   156
233     1     1     2    79   156   310
  1     1     2    79   156   387     1
  1     2    79   156   464     1     1
  0     0     0     0     0     0     0
  1     1     1     1     0     0     7
  7     7     7     0     0     0     0
  0     0     0     0     2    79   156
233   774   774   774   774   774   310
774   774   774   774   774   387   774
774   774   774   774   464   774   774
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  1     1     1     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     2     9    16
  1     1     1     2     9    16     1
  1     1     2     9    16     1     1
  1     2     9    16     1     1     1
  0     0     0     0     0     0     0
  1     1     1     0     0     0     0
  0     0     0     0     0     0     0
```

```
  0     0     0     0     2     9    16
 46    46    46    46    46    46    46
 46    46    46    46    46    46    46
 46    46    46    46    46    46    46
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  1     1     1     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     2     9    16
  1     1     1     2     9    16     1
  1     1     2     9    16     1     1
  1     2     9    16     1     1     1
  0     0     0     0     0     0     0
  1     1     1     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     2     9    16
 46    46    46    46    46    46    46
 46    46    46    46    46    46    46
 46    46    46    46    46    46    46
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
```

```
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           0           0           0
           1           1           1           0           0           0           0
           0           0           0           0           0           0           0
           0           0           0           0           2           9          16
         879         879         879         879         879         879         879
         879         879         879         879         879         879         879
         879         879         879         879         879         879         879/
'LOAGBH    IA'
           1          43          85         127/
'LOAGDE    IA'
           1          43          85         127/
'LOBLAS    IA'
           1          13          25          37/
'LOECOA    IA'
           1          73         145         217/
'LOECOV    IA'
           1           9         191         204/
'LORGBH    IA'
           1          16         789         834         879/
'LORGDE    IA'
           1          16         789         834/
'MBPROP    IA' /
'NBTYPE    I '        4
'SPATR     RA' /
'LOCOOR    IA' /
'LOPARA    IA' /
'LPARAS    IA' /
'NSPEC     I ' /
'MBKPES    IA'
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
```

```
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
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           1           1           1           1           1           1           1           1
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           1           1           1           1           1           1           1           1
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           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
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           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
           1           1           1           1           1           1           1           1
```

```
       1        1        1        1        1        1        1        1
       1        1        1        1        1        1        1        1/
'MPRBLK   IA'
       1/
'MSTAT    IA' /
'NXTBLK   IA'
       2        3        4/
'MDBCA    I '       1
'MDIOB    I '   16000
'MDPART   I '       1
'MECDIM   I '     216
'MGDIM    I '     878
'NDSPS    IA' /
'NFSPS    IA' /
'NPS      I ' /
'NTSPS    IA' /
'CFMTPS   AA' /
'MFLFS    IA' /
'NFLFS    IA' /
'NFS      I ' /
'NPSFS    IA' /
'MDODS    IA' /
'NDODS    IA' /
'NDS      I ' /
'NPSDS    IA' /
'TIMETS   RA' /
'NPSTS    IA' /
'NSTPTS   IA' /
'NTS      I ' /
'CNLTIM   AA' /
'CNSTIM   AA' /
'CNUFRQ   AA' /
'CNURAT   AA' /
'CNUTIM   AA' /
'SCLDO    RA' /
'SLIMDO   RA' /
'MSUDO    IA' /
'NCOLDO   IA' /
'NDO      I ' /
'NDSDO    IA' /
'NSUDO    IA' /
'CNLDO    AA' /
'CNSDO    AA' /
'FLIMFL   RA' /
'SCLFL    RA' /
'NCOLFL   IA' /
'NFL      I ' /
'NFSFL    IA' /
'CFLSPC   AA' /
'CNLFL    AA' /
'CNSFL    AA' /
'CNUFL    AA' /
'NPSU     IA' /
'NSU      I ' /
'NSUBLK   IA' /
```

```
'NSUD     IA' /
'NSUDOM   IA' /
'NSUDS    IA' /
'NSUFS    IA' /
'NSUO     IA' /
'NSUPS    IA' /
'NSUTS    IA' /
'NSUX     IA' /
'NXTPSU   IA' /
'AMODE    RA' /
'BUNI     RA' /
'CMODE    RA' /
'NBEXT    I ' /
'NINIT    I ' /
'NMODE    IA' /
'SSPAR    RA' /
'TIMDPO   RA' /
'TIMSSO   RA' /
'TOUTNS   R ' /
'WINXO    R ' /
'WINXX    R ' /
'WINYO    R ' /
'WINYX    R ' /
'XPSMAX   R ' /
'XPSMIN   R ' /
'YPSMAX   R ' /
'YPSMIN   R ' /
'LMDP     IA' /
'MIMDOP   I ' /
'NDPO     IA' /
'NDVECT   I ' /
'NGMAX    I ' /
'NOPSEL   I ' /
'NS1      I ' /
'NSSO     IA' /
'NXPTDD   I ' /
'ECOV     RA'
              0.        1.8377630       0.31415927        1.8377630
       1.0000000        1.8377630        3.6755259               0.
              0.       0.26525840       0.20247358       0.15054981
      0.10860112   0.75634636E-01   0.50557822E-01   0.32192696E-01
  0.19287445E-01   0.10529785E-01   0.45634033E-02   0.89257020E-08
      0.15314698       0.12216777   0.99079087E-01   0.84971756E-01
  0.80840811E-01   0.87568268E-01       0.10592178       0.13653800
      0.17992035       0.23643206       0.30629396      -0.41907203
     -0.48185685      -0.54463947      -0.60742295      -0.67020690
     -0.73298991      -0.79577518      -0.48422948      -0.53615326
     -0.58807832      -0.64000255      -0.69192630      -0.74385095
     -0.79577428      -0.54408258      -0.58603126      -0.62797993
     -0.66992778      -0.71187693      -0.75382560      -0.79577428
     -0.59797323      -0.63093972      -0.66390705      -0.69687396
     -0.72984135      -0.76280826      -0.79577518      -0.64531451
     -0.67039132      -0.69546795      -0.72054499      -0.74562114
     -0.77069813      -0.79577428      -0.68558377      -0.70394892
     -0.72231424      -0.74067914      -0.75904495      -0.77740937
  -0.79577518     -0.71834213     -0.73124737     -0.74415267
  -0.75705808     -0.76996291     -0.78286880     -0.79577386
  -0.74323040     -0.75198811     -0.76074553     -0.76950288
  -0.77826065     -0.78701806     -0.79577553     -0.75997555
  -0.76594198     -0.77190840     -0.77787489     -0.78384107
  -0.78980768     -0.79577422     -0.76839411     -0.77295750
  -0.77752107     -0.78208441     -0.78664786     -0.79121149
  -0.79577482      0.              0.              0.
   0.              0.              0.              0.
   0.64531410      0.61433488      0.58335584      0.55237687
   0.52139789      0.49041930      0.45944074      0.59797364
   0.57488501      0.55179673      0.52870810      0.50561899
   0.48253030      0.45944074      0.54408300      0.52997565
   0.51586831      0.50176144      0.48765409      0.47354677
   0.45944074      0.48422903      0.48009807      0.47596627
   0.47183487      0.46770394      0.46357256      0.45944029
   0.41907248      0.42579994      0.43252826      0.43925661
   0.44598451      0.45271283      0.45944118      0.34932184
   0.36767536      0.38602844      0.40438151      0.42273459
   0.44108766      0.45944074      0.27574569      0.30636188
   0.33697677      0.36759299      0.39820877      0.42882410
   0.45944029      0.19914754      0.24252988      0.28591311
   0.32929415      0.37267691      0.41605970      0.45944160
   0.12036869      0.17688040      0.23339212      0.28990385
   0.34641644      0.40292728      0.45943987      0.40269680E-01
   0.11013160      0.17999396      0.24985631      0.31971690
   0.38958013      0.45944074      0.              0.
   0.              0.              0.              0.
   0.              1.8377628       1.0000000       1.0000000
   1.0000000       0.              0.              0.30629385
   0.10471975      1.8377630       1.0000000       7.3510518
   7.6573453       7.9636397       8.2699337       8.5762272
   8.8825216       9.1888151       0.              0.
   1.2251754       0.10471976      1.8377630       1.0000000
   0.              1.2251754       2.4503508       3.6755259
   4.9007015       6.1258769       7.3510518     /
'BCATR     RA' /
'G         RA'
   0.              1.1547003       0.              0.12820990
   0.12820990      0.57735014      0.57735014      0.
   0.              0.57735020      0.57735020      0.25641984
   0.              1.1547004       0.              0.
   0.99861674E-01  0.99226177E-01  0.98598778E-01  0.97979255E-01
   0.97367473E-01  0.96763238E-01  0.              0.16881576
   0.16741750      0.16604303      0.16469175      0.16336301
   0.16205621      0.              0.12963645      0.12794174
   0.12629247      0.12468680      0.12312294      0.12159920
   0.              0.99606149E-01  0.97616017E-01  0.95705837E-01
   0.93870752E-01  0.92106350E-01  0.90408541E-01  0.
   0.79652444E-01  0.77494107E-01  0.75450577E-01  0.73512904E-01
   0.71673013E-01  0.69923647E-01  0.              0.72436430E-01
   0.70237719E-01  0.68168588E-01  0.66217944E-01  0.64375855E-01
   0.62633507E-01  0.              0.79652458E-01  0.77494107E-01
   0.75450622E-01  0.73512957E-01  0.71673080E-01  0.69923699E-01
   0.              0.99606588E-01  0.97616412E-01  0.95706224E-01
```

```
   0.93871161E-01  0.92106745E-01  0.90408921E-01  0.
   0.12963705      0.12794235      0.12629312      0.12468744
   0.12312355      0.12159980      0.              0.16881630
   0.16741805      0.16604361      0.16469231      0.16336359
   0.16205679      0.              0.99861823E-01  0.99226288E-01
   0.98598823E-01  0.97979277E-01  0.97367480E-01  0.96763298E-01
   0.              0.78127372      1.5902196       1.6503247
   1.7348341       1.8432645       1.9751451       1.0373045
   1.0286083       2.1051650       2.1922715       2.2991211
   2.4251113       2.5696664       1.3375471       1.3590720
   2.7864311       2.8992114       3.0252552       3.1639326
   3.3146470       1.7104578       1.7359107       3.5544906
   3.6831810       3.8177695       3.9578531       4.1030617
   2.1011469       2.0168402       4.1212530       4.2531991
   4.3858743       4.5192156       4.6531706       2.3713801
   2.0168400       4.1212535       4.2532005       4.3858757
   4.5192199       4.6531749       2.3713832       1.7359085
   3.5544856       3.6831727       3.8177590       3.9578388
   4.1030455       2.1011386       1.3590642       2.7864165
   2.8991992       3.0252435       3.1639223       3.3146367
   1.7104527       1.0286051       2.1051576       2.1922617
   2.2991097       2.4250998       2.5696526       1.3375405
   0.78127187      1.5902156       1.6503226       1.7348328
   1.8432628       1.9751452       1.0373033       0.
   0.              0.              0.              0.
   0.              0.              2.1149962       4.2118802
   4.1849742       4.1584101       4.1321812       4.1062818
   2.0445879       5.0704751      10.082571        9.9961662
   9.9112797       9.8278704       9.7458935       4.8459749
   6.6716828      13.221588       13.042761       12.868878
  12.699735       12.535128        6.2137928       8.6659012
  17.091957       16.743439       16.409176       16.088289
  15.779984        7.7902174      10.571463       20.752745
  20.191349       19.659748       19.155628       18.676893
   9.1848326      11.405147       22.343651       21.675022
  21.045259       20.451077       19.889536        9.7652140
  10.571465       20.752747       20.191355       19.659761
  19.155643       18.676908        9.1848383       8.6658602
  17.091873       16.743355       16.409094       16.088215
  15.779907        7.7901802       6.6716537      13.221528
  13.042705       12.868825       12.699677       12.535070
   6.2137647       5.0704584      10.082541        9.9961386
   9.9112530       9.8278446       9.7458696       4.8459620
   2.1149948       4.2118769       4.1849685       4.1584029
   4.1321745       4.1062737       2.0445850      -0.10455717E-01
  -0.22643864E-01 -0.34677014E-01 -0.46558369E-01 -0.58290683E-01
  -0.69876738E-01  0.             -0.20565215E-01 -0.30262664E-01
  -0.39769199E-01 -0.49090352E-01 -0.58231559E-01 -0.67198008E-01
   0.             -0.27100530E-01 -0.34150742E-01 -0.40980522E-01
  -0.47600102E-01 -0.54019205E-01 -0.60246635E-01  0.
  -0.26250262E-01 -0.30461365E-01 -0.34479469E-01 -0.38317390E-01
  -0.41987073E-01 -0.45499414E-01  0.             -0.14636323E-01
  -0.16001893E-01 -0.17288402E-01 -0.18502627E-01 -0.19650467E-01
  -0.20737203E-01  0.              0.41883215E-02  0.55387933E-02
   0.68092356E-02  0.80066035E-02  0.91370111E-02  0.10205971E-01
```

```
          0.      0.19065125E-01  0.23199331E-01  0.27131785E-01
  0.30877117E-01  0.34448233E-01  0.37857044E-01          0.    
  0.23287589E-01  0.30258305E-01  0.36992617E-01  0.43502241E-01
  0.49798589E-01  0.55891808E-01          0.      0.18765664E-01
  0.28418144E-01  0.37863322E-01  0.47107887E-01  0.56158133E-01
  0.65020040E-01          0.      0.95812986E-02  0.21751065E-01
  0.33752631E-01  0.45589328E-01  0.57264578E-01  0.68781868E-01
          0.              0.              0.              0.    
          0.              0.              0.              0.    
 -0.14535854E-01 -0.26671950E-01 -0.38654190E-01 -0.50485574E-01
 -0.62168777E-01 -0.73706783E-01          0.     -0.23819247E-01
 -0.33452440E-01 -0.42896561E-01 -0.52157138E-01 -0.61239541E-01
 -0.70148841E-01          0.     -0.29475717E-01 -0.36451302E-01
 -0.43209873E-01 -0.49761623E-01 -0.56115873E-01 -0.62281281E-01
          0.     -0.27676212E-01 -0.31821504E-01 -0.35778154E-01
 -0.39558727E-01 -0.43174792E-01 -0.46636961E-01          0.    
 -0.15100730E-01 -0.16439138E-01 -0.17700858E-01 -0.18892324E-01
 -0.20019248E-01 -0.21086693E-01          0.      0.46478133E-02
  0.59707821E-02  0.72161532E-02  0.83905384E-02  0.94999094E-02
  0.10549456E-01          0.      0.20466538E-01  0.24531757E-01
  0.28400335E-01  0.32086216E-01  0.35601929E-01  0.38959183E-01
          0.      0.25638148E-01  0.32528754E-01  0.39186824E-01
  0.45624185E-01  0.51851723E-01  0.57879396E-01          0.    
  0.22006592E-01  0.31589217E-01  0.40966786E-01  0.50145943E-01
  0.59132684E-01  0.67933261E-01          0.      0.13656783E-01
  0.25770100E-01  0.37716366E-01  0.49498793E-01  0.61121125E-01
  0.72586298E-01          0.              0.              0.    
          0.              0.              0.              0.    
          0.     -0.95813340E-02 -0.21751113E-01 -0.33752490E-01
 -0.45589183E-01 -0.57264481E-01 -0.68781659E-01          0.    
 -0.18765368E-01 -0.28417861E-01 -0.37863102E-01 -0.47107633E-01
 -0.56157876E-01 -0.65019891E-01          0.     -0.23287632E-01
 -0.30258322E-01 -0.36992569E-01 -0.43502260E-01 -0.49798623E-01
 -0.55891793E-01          0.     -0.19065030E-01 -0.23199195E-01
 -0.27131792E-01 -0.30877059E-01 -0.34448165E-01 -0.37857056E-01
          0.     -0.41887076E-02 -0.55391858E-02 -0.68096011E-02
 -0.80069629E-02 -0.91373688E-02 -0.10206279E-01          0.    
  0.14636194E-01  0.16001754E-01  0.17288296E-01  0.18502524E-01
  0.19650362E-01  0.20737154E-01          0.      0.26250236E-01
  0.30461380E-01  0.34479339E-01  0.38317323E-01  0.41987006E-01
  0.45499269E-01          0.      0.27100645E-01  0.34150887E-01
  0.40980734E-01  0.47600254E-01  0.54019354E-01  0.60246833E-01
          0.      0.20565461E-01  0.30262889E-01  0.39769359E-01
  0.49090542E-01  0.58231771E-01  0.67198105E-01          0.    
  0.10455638E-01  0.22643773E-01  0.34677118E-01  0.46558470E-01
  0.58290731E-01  0.69876909E-01          0.              0.    
          0.              0.              0.              0.    
          0.              0.     -0.13656871E-01 -0.25770068E-01
 -0.37716180E-01 -0.49498737E-01 -0.61120916E-01 -0.72586171E-01
          0.     -0.22006292E-01 -0.31588964E-01 -0.40966574E-01
 -0.50145648E-01 -0.59132483E-01 -0.67933075E-01          0.    
 -0.25638195E-01 -0.32528725E-01 -0.39186802E-01 -0.45624215E-01
 -0.51851742E-01 -0.57879347E-01          0.     -0.20466382E-01
 -0.24531703E-01 -0.28400321E-01 -0.32086141E-01 -0.35601895E-01
 -0.38959201E-01          0.     -0.46482114E-02 -0.59711640E-02
```

```
 -0.72165099E-02 -0.83909044E-02 -0.95002456E-02 -0.10549754E-01
          0.      0.15100585E-01  0.16439009E-01  0.17700758E-01
  0.18892217E-01  0.20019172E-01  0.21086652E-01          0.    
  0.27676253E-01  0.31821433E-01  0.35778046E-01  0.39558679E-01
  0.43174695E-01  0.46636809E-01          0.      0.29475827E-01
  0.36451492E-01  0.43210056E-01  0.49761761E-01  0.56116037E-01
  0.62281515E-01          0.      0.23819497E-01  0.33452641E-01
  0.42896729E-01  0.52157383E-01  0.61239671E-01  0.70148967E-01
          0.      0.14535723E-01  0.26671935E-01  0.38654327E-01
  0.50485585E-01  0.62168945E-01  0.73706843E-01          0.    
          0.              0.              0.              0.    
          0.              0.              0.              0.    
          0.      0.95836513E-01  0.19082357      0.18956216    
  0.18831736      0.18708883      0.18587625      0.92537835E-01
  0.73949762E-01  0.14687833      0.14537013      0.14389281    
  0.14244547      0.14102708      0.70047855E-01  0.56711275E-01
  0.11217331      0.11034545      0.10857648      0.10686356    
  0.10520410      0.52061733E-01  0.44093203E-01  0.86760513E-01
  0.84697992E-01  0.82731523E-01  0.80854513E-01  0.79061031E-01
  0.38952470E-01  0.37067294E-01  0.72637834E-01  0.70491932E-01
  0.68469241E-01  0.66559486E-01  0.64753383E-01  0.31798922E-01
  0.37067294E-01  0.72637819E-01  0.70491895E-01  0.68469211E-01
  0.66559412E-01  0.64753339E-01  0.31798881E-01  0.44093266E-01
  0.86760670E-01  0.84698193E-01  0.82731754E-01  0.80854818E-01
  0.79061344E-01  0.38952619E-01  0.56711599E-01  0.11217391    
  0.11034595      0.10857694      0.10686396      0.10520446    
  0.52061930E-01  0.73950045E-01  0.14687891      0.14537087    
  0.14389366      0.14244632      0.14102793      0.70048250E-01
  0.95836729E-01  0.19082397      0.18956240      0.18831757    
  0.18708898      0.18587644      0.92537977E-01          0.    
          0.              0.              0.              0.    
          0.              0.      0.75065869      0.77373898    
  0.80863386      0.85511959      0.91297668      0.98199373    
          0.       1.8062228       1.8681877       1.9526044    
   2.0589259       2.1866245       2.3351893              0.    
   2.3898044       2.4812539       2.5897014       2.7145102    
   2.8550782       3.0108306              0.       3.1144331    
   3.2308145       3.3572211       3.4931009       3.6379423    
   3.7912674              0.       3.8048618       3.9340169    
   4.0666738       4.2025752       4.3414917       4.4832158    
          0.       4.1063681       4.2380023       4.3704042    
   4.5035043       4.6372471       4.7715802              0.    
   3.8048620       3.9340174       4.0666723       4.2025738    
   4.3414898       4.4832139              0.       3.1144199    
   3.2308016       3.3572078       3.4930856       3.6379256    
   3.7912502              0.       2.3897936       2.4812434    
   2.5896907       2.7144992       2.8550677       3.0108199    
          0.       1.8062171       1.8681813       1.9525982    
   2.0589194       2.1866176       2.3351817              0.    
  0.75065714      0.77373803      0.80863357      0.85511935    
  0.91297710      0.98199368              0.       8.8286505    
   8.7694445       8.7110357       8.6533995       8.5965242    
   8.5403891              0.       11.557105       11.436394    
   11.318191       11.202429       11.089024       10.977905    
          0.       15.195367       14.942942       14.698807    
```

```
     14.462558         14.233815         14.012220                0.
     19.333557         18.865198         18.419056         17.993578
     17.587368         17.199148                0.         22.410883
     21.738235         21.104799         20.507252         19.942633
     19.408276                0.         22.410929         21.738272
     21.104834         20.507280         19.942650         19.408295
            0.         19.333490         18.865143         18.419008
     17.993549         17.587349         17.199127                0.
     15.195296         14.942861         14.698720         14.462464
     14.233716         14.012126                0.         11.557053
     11.436354         11.318160         11.202402         11.088999
     10.977879                0.         8.8286390         8.7694302
     8.7110176         8.6533785         8.5965023         8.5403719
            0.                0.                0.                0.
            0.                0.                0.                0.
            0.        0.21208785        0.20377067        0.19608121
    0.18895102        0.18232115        0.17614076                0.
    0.69803166         1.4245545         1.4815366         1.5385187
     1.5955007         1.6524831        0.84048712         3.8175814
     7.4854531         7.1973333         6.9305801         6.6828985
     6.4523134         3.1705332                0.                0.
    0.10604394        0.20792928        0.19992596        0.19251613
    0.18563610        0.17923096        0.88070385E-01     1.3960634
     1.4530457         1.5100280         1.5670098         1.6239921
     1.6809745                0.         7.6351633         7.3357444
     7.0589242         6.8022370         6.5635614         6.3410668
            0.                0.         10.392303         3.4641011
     2.0784609         1.4846147         1.1547003        0.94475478
            0.                0.        0.42736638E-01    0.11396435
    0.17094652        0.22792873        0.28491092        0.15670100
     11.691339         15.588453         6.2353811         4.0084596
     2.9692292         2.3618870         1.0628490                0.
            0.                0.         1.7320508         2.7712815
     1.7815379         1.3196577         1.0497277        0.47237745
    0.28491097E-01    0.85473284E-01    0.14245546        0.19943765
    0.25641987        0.31340203                0.         23.382683
     7.7942276         4.6765366         3.3403833         2.5980759
     2.1256983    /
'B         RA' /
'C         RA' /
'D         RA' /
'COORDS    RA' /
```

```
t130.out
'NLRES    L ' /

CHLAB1    replace these four lines
CHLAB2    by run labelling information
CHLAB3    which will appear at the start
CHLAB4    of the NOUT channel output
'CHLAB5   A ' /
'NDIARY   I '       7
'NIN      I '       1
'NLEDGE   I '       8
'NONLIN   I '       6
'NOUT     I '       2
'NPRINT   I '       2
'NPUNCH   I '       7
'NREC     I '       1
'NRUN     I '     125
'NADUMP   IA' /
'NPDUMP   IA' /
'NVDUMP   IA' /
'NLCHED   L ' /
'NLHEAD   LA' /
'NLOMT1   LA' /
'NLOMT2   LA' /
'NLOMT3   LA' /
'NLREPT   L ' /
'COUR     R ' /
'DT       R '   0.15057594E-12
'SCALE    RA'
   0.45172779E-04   0.15057594E-12   0.30000000E+09   0.22654589E+11
    75.515297       0.45172779E-04    22137.225        376.99115
   0.15409501E-06   0.40874967E-09   0.15409501E-06   0.40874967E-09
   0.40874967E-09   0.13302959E+13   0.40874967E-09   0.26525822E-02
    46.228500        376.99115    /
'NSUBS    I '       1
'ROTG2L   RA'
    1.0000000             0.              0.
           0.      1.0000000              0.
           0.             0.       1.0000000
    1.0000000             0.              0.
  -0.36140069E-07  1.0000000              0.
           0.             0.       1.0000000
  -0.49999982     -0.86602539             0.
   0.86602539     -0.49999985             0.
           0.             0.      0.99999994
  -0.50000042      0.86602521             0.
  -0.86602527     -0.50000042             0.
           0.             0.       1.0000000
    1.0000000             0.              0.
           0.      1.0000000              0.
           0.             0.      0.99999988
    1.0000000      0.36140072E-07         0.
  -0.14456022E-06  1.0000000              0.
           0.             0.       1.0000000
  -0.50000000     -0.86602557             0.
```

```
   0.86602551     -0.49999988             0.
           0.             0.       1.0000002
  -0.50000036      0.86602521             0.
  -0.86602497     -0.50000036             0.
           0.             0.      0.99999994    /
'XYZBLK   RA'
           0.             0.              0.
    11.068613             0.              0.
           0.             0.              0.
           0.             0.       22.137226
    11.068613     -0.86205537E-05         0.
    11.068613             0.       22.137226
           0.             0.       22.137226
    11.068613     -0.86205537E-05  22.137226
    11.068613             0.              0.
    22.137226     -0.40002041E-06         0.
   -5.5343046      9.5857019              0.
    11.068613             0.       22.137226
   -11.068610      19.171404              0.
    22.137226     -0.40002041E-06  22.137226
   -5.5343046      9.5857019       22.137226
   -11.068610      19.171404       22.137226
   -5.5343046      9.5857010              0.
   -11.068609      19.171402              0.
   -5.5343099     -9.5856962              0.
   -5.5343046      9.5857010       22.137222
   -11.068618     -19.171396              0.
   -11.068609      19.171402       22.137222
   -5.5343099     -9.5856962       22.137222
   -11.068618     -19.171396       22.137222
   -5.5343099     -9.5856981              0.
   -11.068621     -19.171398              0.
    11.068614     -0.64427804E-05         0.
   -5.5343099     -9.5856981       22.137226
    22.137228     -0.12241283E-04         0.
   -11.068621     -19.171398       22.137226
    11.068614     -0.64427804E-05  22.137226
    22.137228     -0.12241283E-04  22.137226
           0.             0.       22.137226
    11.068613             0.       22.137226
           0.             0.       22.137226
           0.             0.       44.274445
    11.068613     -0.86205537E-05  22.137226
    11.068613             0.       44.274445
           0.             0.       44.274445
    11.068613     -0.86205537E-05  44.274445
    11.068613             0.       22.137226
    22.137226     -0.16000811E-05  22.137226
   -5.5343046      9.5857038       22.137226
    11.068613             0.       44.274452
   -11.068610      19.171406       22.137226
    22.137226     -0.16000811E-05  44.274452
   -5.5343046      9.5857038       44.274452
   -11.068610      19.171406       44.274452
   -5.5343046      9.5857010       22.137222
   -11.068611        19.171402        22.137222
   -5.5343084       -9.5856991        22.137222
   -5.5343046        9.5857010        44.274456
   -11.068618       -19.171396        22.137222
   -11.068611        19.171402        44.274456
   -5.5343084       -9.5856991        44.274456
   -11.068618       -19.171396        44.274456
   -5.5343099       -9.5856981        22.137226
   -11.068620       -19.171392        22.137226
    11.068614      -0.10952726E-04    22.137226
   -5.5343099       -9.5856981        44.274445
    22.137226      -0.18039786E-04    22.137226
   -11.068620       -19.171392        44.274445
    11.068614      -0.10952726E-04    44.274445
    22.137226      -0.18039786E-04    44.274445    /
'MBKPAT    IA'
      -43       -47       -49       -50       -52        52        50       51/
'MBKTYP    IA'
        1         2         2         2         1         2         2        2/
'MEMBCA    IA'
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        0         0         0         3         0         0         0        5
        0         0         7         0         0         0         0        9
        0         0         0         0       547         0         0      733
        0       919/
'MPABCA    IA' /
'MPATBK    IA'
        1         1
        1         2
        1         3
        1         4
        1         5
        1         1
        1         1
        2         3
        2         4
        2         6
        2         2
        2         2
        3         4
        3         7
        3         3
        3         3
        4         8
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        5         5
        5         6
        5         7
        5         8
        5         5
        5         5
        6         7
        6         8
        6         6
```

```
        6         6
        7         8
        7         7
        7         7
        8         8
        8         8
        1         4
        1         2
        1         5
        1         5
        1         6
        2         5
        1         7
        3         5
        1         8
        4         5
        2         8
        4         6
        2         7
        3         6
        3         8
        4         7
        5         8
        5         6/
'MPATO     IA'
    24000         0
  5000000         0
  5008000         0
  5016000         0
  5000010   5000000
        0         0
        0         0
     8000         0
        0      8000
       10         0
  5000000         0
        0         0
     8000         0
       10         0
  5000000         0
        0         0
       10         0
  5000000         0
        0         0
    24000         0
  5000000         0
  5008000         0
  5016000         0
       10         0
        0         0
     8000         0
        0      8000
  5000000         0
       10         0
     8000         0
  5000000         0
       10         0
  5000000         0
       10         0
  5000000      8000
  5024000         0
       10     24000
    24010         0
  5000010         0
       10   5000000
  5008010         0
       10   5008000
  5016010         0
       10   5016000
       10      8000
     8010         0
     8010         0
       10      8000
     8010         0
       10      8000
  5000000      8000
  5024000/
'MPATX    IA'
  5024010   5000010
  5008010      8010
  5016010      8010
  5024010      8010
    24010     24000
  5024000  24005000
    24010  10024000
  5008010   5000010
  5000010   5008010
  5008010   5008000
  5008010   8010000
  5008000   8005000
  5008010   5000010
  5008010   5008000
  5008010   8010000
  5008000   8005000
  5008010   5008000
  5008010   8010000
  5008000   8005000
  5024010   5000010
  5008010      8010
  5016010      8010
  5024010      8010
  5024010   5024000
    24010  10024000
  5008010   5000010
  5000010   5008010
  5008010   8010000
  5008010   5008000
  5008010   5000010
  5008010   8010000
  5008010   5008000
```

```
  5008010   8010000
  5008010   5008000
  5000010      8010
  5024010        10
  5000010   5024000
  5024010   5000000
  5008010      8000
     8010   5008000
  5016010      8000
     8010   5016000
  5024010      8000
     8010   5024000
  5000010   5008000
  5008010   5000000
  5008010   5000000
  5000010   5008000
  5008010   5000000
  5000010   5008000
  5000010      8010
  5024010        10/
'MPATYP   IA'
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        1         1        -1        -2         1         1        -1        -2
        1        -1        -2         1         1         1         1        -3
        4         1         1        -1        -3         1        -1        -3
       -1        -3         2         2         2         2         2         2
        2         2         2         2         2         2         2         2
        2         2         2         2/
'NBLOCK   I '         8
'NPATCH   I '        52
'NXTPAT   IA'
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        1         0
       -2         0
       -3         0
       -4         0
       -5         5
       -6         6
        2         3
       -8         4
       -9         0
      -10        10
      -11        11
        8         9
      -13         0
      -14         0
      -15        15
       13         0
      -17        17
      -18        18
        5       -20
       20        10
      -21        14
      -22        17
      -23        23
     -24        24
      21        22
     -26        23
     -27        27
     -28        28
      26        27
     -30        30
     -31        31
      30        32
     -33        33
      -7       -19
     -35       -12
     -36       -25
     -37        37
     -38       -29
      36        38
     -39       -32
     -16        40
     -41       -34
      35        42
     -40        43
     -44        39
     -45        41
     -42        46
     -48        45
     -46        47
      44        49
     -51        48/
'LBLAS    IA'
       5        24        10         1         6       150      1650         0
       3         2         1         0         5         8        10         1
       6        54       594         0         3        2/
'LECOVA   IA'
       0         0         0         2         0         0
       0         0         0         1         0         0
       0         0         0         1         0         0
       0         0         0         1         0         0
       0         0         0         3         0         0
       0         0         0         1         0         0
       0         0         0         1         0         0
       0         0         0         1         0         0
       0         0         0         4         0         0
       0         0         0         5         0         0
       1         0         0         6         0         0
       0         0         0         5         0         0
       0         0         0         0         0         0
       0         0         0         0         0         0
       0         0         0         0         0         0
       0         0         0         0         0         0
       0         0         0         0         0         0
       0         0         0         0         0         0
       0         0         0         0         0         0
       0         0         0         0         0         0
       0         0         0         0         0         0
       0         0         0         0         0         0
```

```
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       0         0         0         0         0         0
       0         0         0         0         0         0
       0         0         0         0         0         0
       0         0         0         0         0         0
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       0         0         0         1         0         0
       0         0         0         1         0         0
       0         0         0         1         0         0
       0         0         0         3         0         0
```

```
     0      0      0      1      0      0
     0      0      0      1      0      0
     0      0      0      1      0      0
     0      0      0      4      0      0
     0      0      0      5      0      0
     1      0      0      6      0      0
     0      0      0      5/
'LGBHAD    IA'
     1      1      1      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0     22     28     34
     1      1      1     22     28     34      1
     1      1     22     28     34      1      1
     1     22     28     34      1      1      1
     0      0      0      0      0      0      0
     1      1      1      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0     22     28     34
    40     40     40     40     40     40     40
    40     40     40     40     40     40     40
    40     40     40     40     40     40     40
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     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
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     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
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     0      0      0      0     22     28     34
     1      1      1     22     28     34      1
     1      1     22     28     34      1      1
```

```
     1     22     28     34      1      1      1
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     1      1      1      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0     22     28     34
    40     40     40     40     40     40     40
    40     40     40     40     40     40     40
    40     40     40     40     40     40     40
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
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     0      0      0      0      0      0      0
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     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      0      0      0
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     0      0      0      0      0      0      0
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     0      0      0      0      0      0      0
     1      1      1      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0     22     28     34
    79     79     79     79     79     79     79
    79     79     79     79     79     79     79
    79     79     79     79     79     79     79/
'LGDEAD    IA'
     1      1      1      0      0      0      0
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     0      0      0      0      2      8     14
     1      1      1      2      8     14      1
     1      1      2      8     14      1      1
     1      2      8     14      1      1      1
     0      0      0      0      0      0      0
     1      1      1      0      0      0      0
     0      0      0      0      0      0      0
     0      0      0      0      2      8     14
    40     40     40     40     40     40     40
```

```
  40   40   40   40   40   40   40
  40   40   40   40   40   40   40
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   0    0    0    0    0    0    0
   0    0    0    0    0    0    0
   0    0    0    0    0    0    0
   0    0    0    0    0    0    0
   0    0    0    0    0    0    0
   0    0    0    0    0    0    0
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   1    2    8   14    1    1    1
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   0    0    0    0    0    0    0
   0    0    0    0    2    8   14
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  40   40   40   40   40   40   40
  40   40   40   40   40   40   40
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```

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         0         0         0         0         2         8        14
        79        79        79        79        79        79        79
        79        79        79        79        79        79        79
        79        79        79        79        79        79        79/
'LOAGBH   IA'
         1        43/
'LOAGDE   IA'
         1        43/
'LOBLAS   IA'
         1        13/
'LOECOA   IA'
         1        73/
'LOECOV   IA'
         1        13/
'LORGBH   IA'
         1        40        79/
'LORGDE   IA'
         1        40/
'MBPROP   IA' /
'NBTYPE   I '         2
'SPATR    RA' /
'LOCOOR   IA' /
'LOPARA   IA' /
'LPARAS   IA' /
'NSPEC    I ' /
'MBKPES   IA'
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         1         1         1         1         1         1         1         1
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'MPRBLK   IA'
        1/
'MSTAT    IA' /
'NXTBLK   IA'
        2         3         4         5         6         7         8/
'MDBCA    I '     1105
'MDIOB    I '    16000
'MDPART   I '        1
'MECDIM   I '       24
'MGDIM    I '       78
'NDSPS    IA'
        1         2/
'NFSPS    IA'
        1         2/
'NPS      I '        2
'NTSPS    IA'
        1         2/
'CFMTPS   AA'
 'grl                                 ' 'grl                                    '/
'MFLFS    IA'
        3         1/
'NFLFS    IA'
        1         2         3         0         0         0         0         0
        0         0
        4/
'NFS      I '        2
'NPSFS    IA'
        1         2/
'MDODS    IA'
        1         1/
'NDODS    IA'
        1         0         0         0         0         0         0         0
        0         0
        2/
'NDS      I '        2
'NPSDS    IA'
        1         2/
'TIMETS   RA'
          0.        0.20000000E-10   0.15000000E-11            0.
          0.        0.10000000E+10
          0.        0.20000000E-10   0.15000000E-11            0.
          0.        0.10000000E+10/
'NPSTS    IA'
        1         2/
'NSTPTS   IA' /
'NTS      I '        2
'CNLTIM   AA'
 'Time                                                                   '
 'Time                                                                   '/
'CNSTIM   AA'
 't       ' 't       '/
'CNUFRQ   AA'
 'GHz     ' 'GHz     '/
'CNURAT   AA'
 '/ns     ' '/ns     '/
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```
'CNUTIM   AA'
 'ns      ' 'ns      '/
'SCLDO    RA' /
'SLIMDO   RA'
          0.        20.000002
          0.        20.000002    /
'MSUDO    IA'
        8        2/
'NCOLDO   IA'
        1        1/
'NDO      I '        2
'NDSDO    IA'
        1        2/
'NSUDO    IA'
        1        2        3        4        6        7        8        9
        0        0
        5       10/
'CNLDO    AA'
 'axial distance (m)                                                      '
 'axial distance (m)                                                      '/
'CNSDO    AA'
 'z (m)   ' 'z (m)   '/
'FLIMFL   RA'
   -10.000000       10.000000
   -10.000000       10.000000
   -10.000000       10.000000
          0.        20.000000    /
'SCLFL    RA'
          0.               0.
          0.               0.
          0.       -1.0000000    /
'NCOLFL   IA'
        2        3        4        2/
'NFL      I '        4
'NFSFL    IA'
        1        1        1        2/
'CFLSPC   AA'
 'int D.dS                                                                '
 'int B.dS                                                                '
 'int j.dS                                                                '
 'int E.dl                                                                '/
'CNLFL    AA'
 'total displacement current                                              '
 'total magnetic flux                                                     '
 'total electron current                                                  '
 'radial voltage                                                          '/
'CNSFL    AA'
 'Id      ' 'phi     ' 'Ie      ' 'Vr      '/
'CNUFL    AA'
 'A       ' 'Tm2     ' 'A       ' 'V       '/
'NPSU     IA'
        1        1        1        1        5        6        6        6
        6       10/
'NSU      I '       10
'NSUBLK   IA'
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        1        2        3        4        2        5        6        7
        8        6/
'NSUD     IA'
        1        2        3
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        1        2        3
        1        2        3/
'NSUDOM   IA'
        1        1        1        1        2        1        1        1
        1        2/
'NSUDS    IA'
        1        1        1        1        2        1        1        1
        1        2/
'NSUFS    IA'
        1        1        1        1        2        1        1        1
        1        2/
'NSUO     IA'
        0        0        0
        0        0        0
        0        0        0
        0        0        0
        0        3        0
        0        0        0
        0        0        0
        0        0        0
        0        0        0
        0        3/
'NSUPS    IA'
        1        1        1        1        2        1        1        1
        1        2/
'NSUTS    IA'
        1        1        1        1        2        1        1        1
        1        2/
'NSUX     IA'
        4       23        9
        4        7        9
        4        7        9
        4        7        9
        4        3        9
        4       23        9
        4        7        9
        4        7        9
        4        7        9
        4        3        9/
'NXTPSU   IA'
        6        0        0        0       10/
'AMODE    RA' /
'BUNI     RA' /
'CMODE    RA' /
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'NBEXT    I ' /
'NINIT    I ' /
'NMODE    IA' /
'SSPAR    RA' /
'TIMDPO   RA' /
'TIMSSO   RA' /
'TOUTNS   R ' /
'WINXO    R ' /
'WINXX    R ' /
'WINYO    R ' /
'WINYX    R ' /
'XPSMAX   R ' /
'XPSMIN   R ' /
'YPSMAX   R ' /
'YPSMIN   R ' /
'LMDP     IA' /
'MIMDOP   I ' /
'NDPO     IA' /
'NDVECT   I ' /
'NGMAX    I ' /
'NOPSEL   I ' /
'NS1      I ' /
'NSSO     IA' /
'NXPTDD   I ' /
'ECOV     RA'
          0.        2.2137225        0.26179940        2.2137225
   1.0000000               0.         2.2137225        4.4274449
   6.6411676        8.8548899         11.068613               0.
          0.        2.2137225        0.26179940        2.2137225
   1.0000000        11.068613         13.282335        15.496058
   17.709780        19.923504         22.137226      /
'BCATR    RA'
          0.        2.4999988                0.        2.4999988
          0.        2.4999988                0.        2.4999988
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    0.37767878      1.3776788      0.37767878      1.3776788
    0.37767878      1.3776788      0.37767878      1.3776788     /
'G         RA'
            0.      3.4509456      1.1503152     0.69018912
    0.49299225     0.38343835             0.             0.
0.88696532E-01     0.23652408     0.35478613     0.47304821
    0.26608965      1.7254728      2.3006303     0.92025220
    0.59159064     0.43821532     0.19171919             0.
            0.             0.     0.57515770     0.92025232
    0.59159082     0.43821535     0.19171920 0.59131034E-01
    0.17739309     0.29565516     0.41391724     0.53217936
            0.      3.4509461      1.1503154     0.69018924
    0.49299234     0.38343844             0.             0.
    0.31372231     0.26545736     0.23006305     0.20299682
    0.18162872             0.     0.32522061     0.70957226
    0.82783437     0.94609630      1.0643585     0.56174475
    0.15686117     0.28958982     0.24776019     0.21652994
    0.19231276 0.90814352E-01             0.             0.
    0.15686119     0.28958988     0.24776024     0.21652995
    0.19231281 0.90814374E-01     0.65044135     0.76870346
    0.88696545      1.0052276      1.1234896             0.
    0.31372240     0.26545736     0.23006308     0.20299685
    0.18162873    /
'B         RA' /
```

```
'C        RA' /
'D        RA' /
'COORDS   RA' /
```

```
    18.746456        11.247877        18.746454
    13.122517        18.746458        18.746454
    9.3732281        9.3732281        37.492916
    18.746454        18.746460        18.746454
    18.746456        11.247877        37.492916
    13.122517        18.746458        37.492916
    18.746454        18.746460        37.492916
           0.        7.4985828        18.746456
    9.3732281        9.3732281        18.746456
           0.        18.746456        18.746456
           0.        7.4985828        37.492912
    13.122519        18.746456        18.746456
    9.3732281        9.3732281        37.492912
           0.        18.746456        37.492912
    13.122519        18.746456        37.492912     /
'MBKPAT    IA'
       -41       -45       -49       -50       -51       -52        51        52/
'MBKTYP    IA'
         1         2         3         4         1         2         3         4/
'MEMBCA    IA' /
'MPABCA    IA' /
'MPATBK    IA'
         1         2
         1         4
         1         5
         1         5
         1         1
         1         1
         2         3
         2         6
         2         6
         2         2
         2         2
         3         4
         3         7
         3         7
         3         3
         3         3
         4         8
         4         8
         4         4
         4         4
         5         6
         5         8
         5         5
         5         5
         6         7
         6         6
         6         6
         7         8
         7         7
         7         7
         8         8
         8         8
         1         6
```

```
         5         2
         1         8
         5         4
         1         3
         2         4
         1         6
         2         5
         1         8
         4         5
         2         7
         6         3
         2         7
         3         6
         3         8
         7         4
         3         8
         4         7
         5         7
         6         8/
'MPATO     IA'
   3000000         0
      4000         0
         5         0
         0         5
         0         0
         0         0
      4000         0
         5         0
         0         5
   3000000         0
         0         0
         0   3000000
         5         0
         0         5
   3000000         0
      4000         0
         5         0
         0         5
      4000         0
         0         0
   3000000         0
      4000         0
         0         0
         0         0
      4000         0
   3000000         0
         0         0
         0   3000000
   3000000         0
      4000         0
      4000         0
         0         0
   3000000         5
   3000005         0
      4000         5
```

```
     4005        0
  3004000        0
     4000  3000000
  3000005        0
        5  3000000
     4005        0
        5     4000
     4000        5
     4005        0
     4005        0
        5     4000
        0  3000005
        5  3000000
        5  3000000
  3000005        0
  3004000        0
     4000  3000000/
'MPATX    IA'
  3004005     4005
  3004005  3000005
  3004005  3004000
  3004000  3004005
     4005  5004000
  3000005  3005000
  3004005  3000005
  3004005  3004000
  3004000  3004005
  3004005  4005000
  3000005  3005000
     4005  3004005
  3004005  3004000
  3004000  3004005
  3004005  4005000
  3004005  5003000
  3004005  3004000
  3004000  3004005
  3004005  5003000
     4005  5004000
  3004005     4005
  3004005  3000005
     4005  5004000
  3000005  3005000
  3004005  3000005
  3004005  4005000
  3000005  3005000
     4005  3004005
  3004005  4005000
  3004005  5003000
  3004005  5003000
     4005  5004000
  3004000     4005
  3004005     4000
  3004000  3000005
  3004005  3000000
  3004005        5
```

```
     4005  3000005
  3004005     4000
     4005  3004000
  3004005  3000000
  3000005  3004000
  3004000  3000005
  3004005  3000000
  3004005  3000000
  3000005  3004000
     4000  3004005
     4005  3004000
     4005  3004000
  3004005     4000
  3004005        5
     4005  3000005/
'MPATYP   IA'
        1        1        1        1       -1       -1        1        1
        1       -1       -1        1        1        1       -1       -1
        1        1       -1       -1        1        1       -1       -1
        1       -1       -1        1       -1       -1       -1       -1
        2        2        2        2        2        2        2        2
        2        2        2        2        2        2        2        2
        2        2        2        2/
'NBLOCK   I '        8
'NPATCH   I '       52
'NXTPAT   IA'
        0        0
       -1        0
       -2        0
       -3        3
       -4        4
       -5        5
        1        0
       -7        0
       -8        8
       -9        9
      -10       10
        7        2
      -12        0
      -13       13
      -14       14
      -15       15
       12        0
      -17       17
      -18        0
      -19       19
        4        9
      -21       18
      -22       22
      -23       23
       21       14
      -25       25
      -26       26
       25       22
      -28       28
     -29       29
      28        0
     -31       31
      -6      -27
     -24      -11
     -33      -32
     -34      -20
     -35      -16
      34       36
     -37       33
     -38      -36
     -39       35
      38       40
     -40      -30
      39       37
     -43       43
      44      -44
     -46       41
      45      -42
     -47       47
      48      -48
      42       50
      46       49/
'LBLAS    IA'
       3        4        5        1        4       20      120        0
      13        1        0        0        3        4        5        1
       4       20      120        0       13        1        0        0
       3        4        5        1        4       20      120        0
      13        1        0        0        3        4        5        1
       4       20      120        0       13        1/
'LECOVA   IA'
       0        1        0        2        0        0
       0        1        0        7        0        0
       0        0        0        1        0        0
       1        0        0       12        0        0
       1        0        0       16        0        0
       0        0        0        1        0        0
       0        0        0        1        0        0
       0        0        0        1        0        0
       0        0        0       20        0        0
       0        0        0       21        0        0
       0        0        0       22        0        0
       0        0        0       23        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
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       0        0        0        0        0        0
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       0        0        0        0        0        0
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       0        0        0        0        0        0
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       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        0        0        0        0        0
       0        1        0        2        0        0
       0        1        0        7        0        0
       0        0        0        1        0        0
       1        0        0       12        0        0
       1        0        0       16        0        0
       0        0        0        1        0        0
       0        0        0        1        0        0
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0     0     0     1     0     0
0     0     0    20     0     0
0     0     0    21     0     0
0     0     0    22     0     0
0     0     0    23     0     0
0     0     0     0     0     0
0     0     0     0     0     0
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0     0     0     0     0     0
0     1     0     2     0     0
0     1     0     7     0     0
0     0     0     1     0     0
1     0     0    12     0     0
1     0     0    16     0     0
0     0     0     1     0     0
0     0     0     1     0     0
0     0     0     1     0     0
0     0     0    20     0     0
0     0     0    21     0     0
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       0          0          0          0          0          0
       0          1          0          2          0          0
       0          1          0          7          0          0
       0          0          0          1          0          0
       1          0          0         12          0          0
       1          0          0         16          0          0
       0          0          0          1          0          0
       0          0          0          1          0          0
       0          0          0          1          0          0
       0          0          0         20          0          0
       0          0          0         21          0          0
       0          0          0         22          0          0
       0          0          0         23/
'LGBHAD   IA'
       1          1          1          1          0          0          4
       4          4          4          0          0          0          0
       0          0          0          0        144        164        184
      62          1          1        144        164        184         82
       1          1        144        164        184        102          1
       1        144        164        184        122          1          1
       0          0          0          0          0          0          0
       1          1          1          1          0          0          4
       4          4          4          0          0          0          0
       0          0          0          0        144        164        184
     204        204        204        204        204        204        204
     204        204        204        204        204        204        204
     204        204        204        204        204        204        204
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
```

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       0          0          0          0          0          0          0
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       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       1          1          1          1          0          0          4
       4          4          4          0          0          0          0
       0          0          0          0        144        164        184
      62          1          1        144        164        184         82
       1          1        144        164        184        102          1
       1        144        164        184        122          1          1
       0          0          0          0          0          0          0
       1          1          1          1          0          0          4
       4          4          4          0          0          0          0
       0          0          0          0        144        164        184
     204        204        204        204        204        204        204
     204        204        204        204        204        204        204
     204        204        204        204        204        204        204
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
       0          0          0          0          0          0          0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     1     1     1     1     0     0     4
     4     4     4     0     0     0     0
     0     0     0     0   144   164   184
    62     1     1   144   164   184    82
     1     1   144   164   184   102     1
     1   144   164   184   122     1     1
     0     0     0     0     0     0     0
     1     1     1     1     0     0     4
     4     4     4     0     0     0     0
     0     0     0     0   144   164   184
   204   204   204   204   204   204   204
   204   204   204   204   204   204   204
   204   204   204   204   204   204   204
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
```

```
     0     0     0     0     0     0     0
     1     1     1     1     0     0     4
     4     4     4     0     0     0     0
     0     0     0     0   144   164   184
    62     1     1   144   164   184    82
     1     1   144   164   184   102     1
     1   144   164   184   122     1     1
     0     0     0     0     0     0     0
     1     1     1     1     0     0     4
     4     4     4     0     0     0     0
     0     0     0     0   144   164   184
   204   204   204   204   204   204   204
   204   204   204   204   204   204   204
   204   204   204   204   204   204   204
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
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     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     1     1     1     1     0     0     4
     4     4     4     0     0     0     0
     0     0     0     0   144   164   184
   813   813   813   813   813   813   813
   813   813   813   813   813   813   813
   813   813   813   813   813   813   813/
'LGDEAD   IA'
     1     1     1     1     0     0     4
     4     4     4     0     0     0     0
     0     0     0     0     2    22    42
    62     1     1     2    22    42    82
     1     1     2    22    42   102     1
```

```
  1     2    22    42   122     1     1
  0     0     0     0     0     0     0
  1     1     1     1     0     0     4
  4     4     4     0     0     0     0
  0     0     0     0     2    22    42
 62   204   204   204   204   204    82
204   204   204   204   204   102   204
204   204   204   204   122   204   204
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
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  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
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  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  1     1     1     1     0     0     4
  4     4     4     0     0     0     0
  0     0     0     0     2    22    42
 62     1     1     2    22    42    82
  1     1     2    22    42   102     1
  1     2    22    42   122     1     1
  0     0     0     0     0     0     0
  1     1     1     1     0     0     4
  4     4     4     0     0     0     0
  0     0     0     0     2    22    42
 62   204   204   204   204   204    82
204   204   204   204   204   102   204
204   204   204   204   122   204   204
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
```

```
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  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
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  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  1     1     1     1     0     0     4
  4     4     4     0     0     0     0
  0     0     0     0     2    22    42
 62     1     1     2    22    42    82
  1     1     2    22    42   102     1
  1     2    22    42   122     1     1
  0     0     0     0     0     0     0
  1     1     1     1     0     0     4
  4     4     4     0     0     0     0
  0     0     0     0     2    22    42
 62   204   204   204   204   204    82
204   204   204   204   204   102   204
204   204   204   204   122   204   204
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
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  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
  0     0     0     0     0     0     0
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  0     0     0     0     0     0     0
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  0     0     0     0     0     0     0
```

```
         0         0         0         0         0         0         0
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         0         0         0         0         0         0         0
         1         1         1         1         0         0         4
         4         4         4         0         0         0         0
         0         0         0         0         2        22        42
        62         1         1         2        22        42        82
         1         1         2        22        42       102         1
         1         2        22        42       122         1         1
         0         0         0         0         0         0         0
         1         1         1         1         0         0         4
         4         4         4         0         0         0         0
         0         0         0         0         2        22        42
        62       204       204       204       204       204        82
       204       204       204       204       204       102       204
       204       204       204       204       122       204       204
         0         0         0         0         0         0         0
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         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         1         1         1         1         0         0         4
         4         4         4         0         0         0         0
```

```
         0         0         0         0         2        22        42
        62       813       813       813       813       813        82
       813       813       813       813       813       102       813
       813       813       813       813       122       813       813/
'LOAGBH   IA'
         1        43        85       127/
'LOAGDE   IA'
         1        43        85       127/
'LOBLAS   IA'
         1        13        25        37/
'LOECOA   IA'
         1        73       145       217/
'LOECOV   IA'
         1        25        49        73/
'LORGBH   IA'
         1       204       407       610       813/
'LORGDE   IA'
         1       204       407       610/
'MBPROP   IA' /
'MFILAX   IA' /
'MODFAX   IA' /
'NBTYPE   I '          4
'SPATR    RA' /
'LOCOOR   IA' /
'LOPARA   IA' /
'LPARAS   IA' /
'NSPEC    I ' /
'MBKPES   IA'
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         1         1         1         1         1         1         1         1
```

uni20.dat

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        1        1        1        1        1        1        1        1
        1        1        1        1        1        1        1        1/
'MPRBLK    IA'
        1/
'MSTAT     IA' /
'NXTBLK    IA'
        2        3        4        5        6        7        8/
'MDBCA     I '        1
'MDIOB     I '    16000
'MDPART    I '        1
'MECDIM    I '       96
'MGDIM     I '      812
'NDSPS     IA' /
'NFSPS     IA' /
'NPS       I ' /
'NTSPS     IA' /
'CFMTPS    AA' /
'MFLFS     IA' /
'NFLFS     IA' /
'NFS       I ' /
```

```
'NPSFS     IA' /
'NDS       I ' /
'NPSDS     IA' /
'TIMETS    RA' /
'NPSTS     IA' /
'NSTPTS    IA' /
'NTS       I ' /
'CNLTIM    AA' /
'CNSTIM    AA' /
'CNUFRQ    AA' /
'CNURAT    AA' /
'CNUTIM    AA' /
'SCLDO     RA' /
'SLIMDO    RA' /
'NCOLDO    IA' /
'NDO       I ' /
'NDSDO     IA' /
'CNLDO     AA' /
'CNSDO     AA' /
'FLIMFL    RA' /
'SCLFL     RA' /
'NCOLFL    IA' /
'NFL       I ' /
'NFSFL     IA' /
'CFLSPC    AA' /
'CNLFL     AA' /
'CNSFL     AA' /
'CNUFL     AA' /
'NPSU      IA' /
'NSU       I ' /
'NSUBLK    IA' /
'NSUD      IA' /
'NSUDOM    IA' /
'NSUDS     IA' /
'NSUFS     IA' /
'NSUO      IA' /
'NSUPS     IA' /
'NSUTS     IA' /
'NSUX      IA' /
'NXTPSU    IA' /
'AMODE     RA' /
'BUNI      RA'
            0.                 0.         15.637561    /
'CMODE     RA' /
'NBEXT     I ' /
'NINIT     I '        1
'NMODE     IA' /
'ENVCO     RA' /
'FRQCO     RA' /
'PHACO     RA' /
'TINTCO    RA' /
'MCOSIG    IA' /
'MINTCO    IA' /
'MTYPCO    IA' /
'NCOM      I ' /
```

```
'NCOSIG   IA' /
'NSIG     I ' /
'LOREDG   IA'
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'LORMDI   IA'
      1        1        1        1        1        1        1        1/
'LORPDI   IA'
      1        1        1        1        1        1        1        1/
'LSTEMB   IA' /
'NUMEDG   IA' /
'NUMMDI   IA' /
'NUMPDI   IA' /
'SSPAR    RA' /
'TIMDPO   RA' /
'TIMSSO   RA' /
'TOUTNS   R ' /
'WINXO    R ' /
'WINXX    R ' /
'WINYO    R ' /
'WINYX    R ' /
'XPSMAX   R ' /
'XPSMIN   R ' /
'YPSMAX   R ' /
'YPSMIN   R ' /
'LMDP     IA' /
'MIMDOP   I ' /
'NDPO     IA' /
'NDVECT   I ' /
'NGMAX    I ' /
'NOPSEL   I ' /
'NS1      I ' /
'NSSO     IA' /
'NXPTDD   I '         7
'ECOV     RA'
          0.         1.8746457         2.1870868         2.4995277
   2.8119686         3.1244094                0.        0.15622048
  0.31244096        0.46866101        0.62488192                0.
  0.31244108        0.62488216        0.93732315         1.8746457
   2.0308661         2.1870866         2.3433070         3.7492914
   1.0000000         1.0000000         1.0000000                0.
          0.         4.3741732         4.0617323         3.7492909
   3.4368505         3.1244094                0.        0.15622075
  0.31244150        0.46866211        0.62488300        0.93732285
  0.62488192        0.31244180    0.11173760E-05         2.3433070
   2.4995279         2.6557479         2.8119686         3.7492914
   1.0000000         1.0000000         1.0000000                0.
          0.         3.1244094         2.8119686         2.4995277
   2.1870866         1.8746457        0.62488192        0.46866113
  0.31244096        0.15621978                0.        0.93732285
  0.62488192        0.31244066                0.         2.3433070
   2.1870863         2.0308661         1.8746457         3.7492914
   1.0000000         1.0000000         1.0000000                0.
          0.         3.1244094         3.4368508         3.7492914
   4.0617328         4.3741732        0.62488192        0.46866128
  0.31244066        0.15622033                0.                0.
```
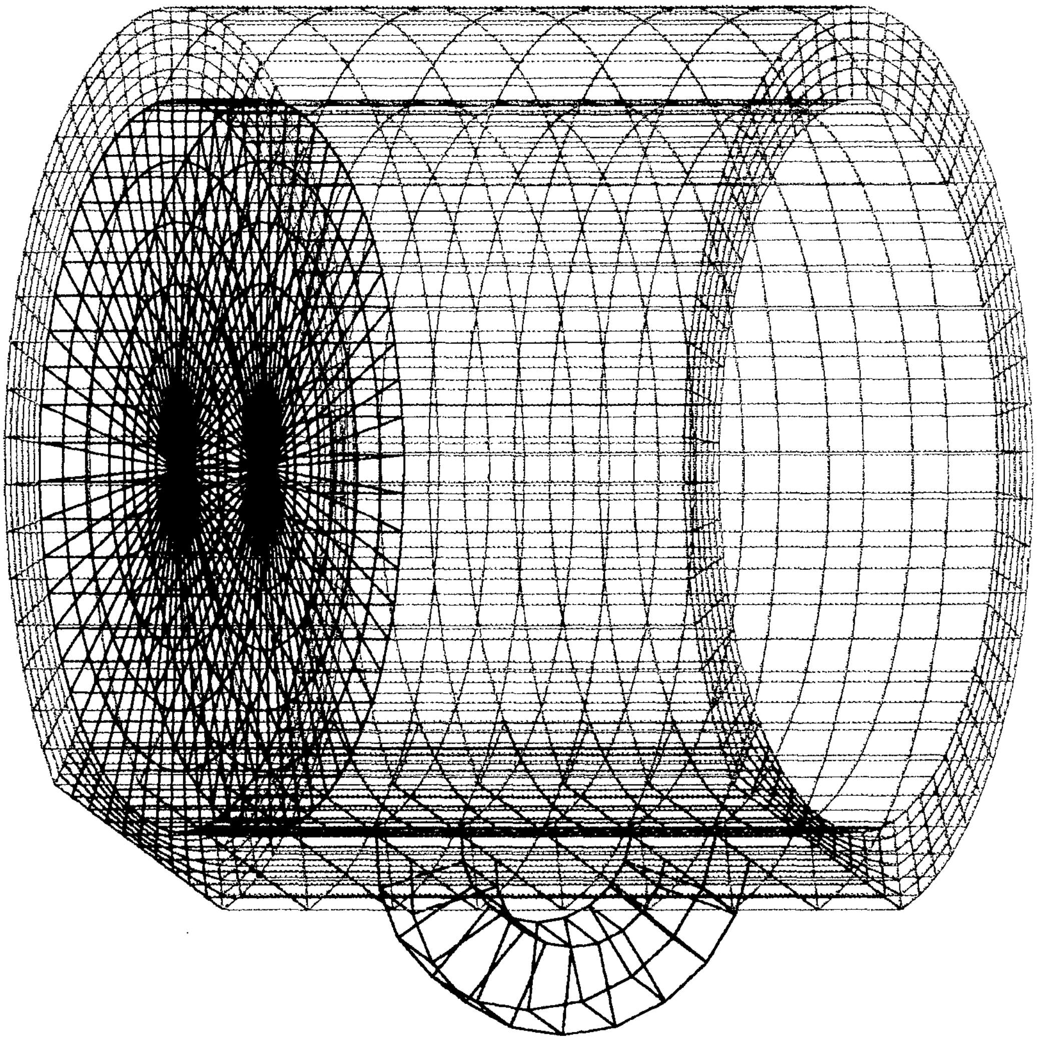
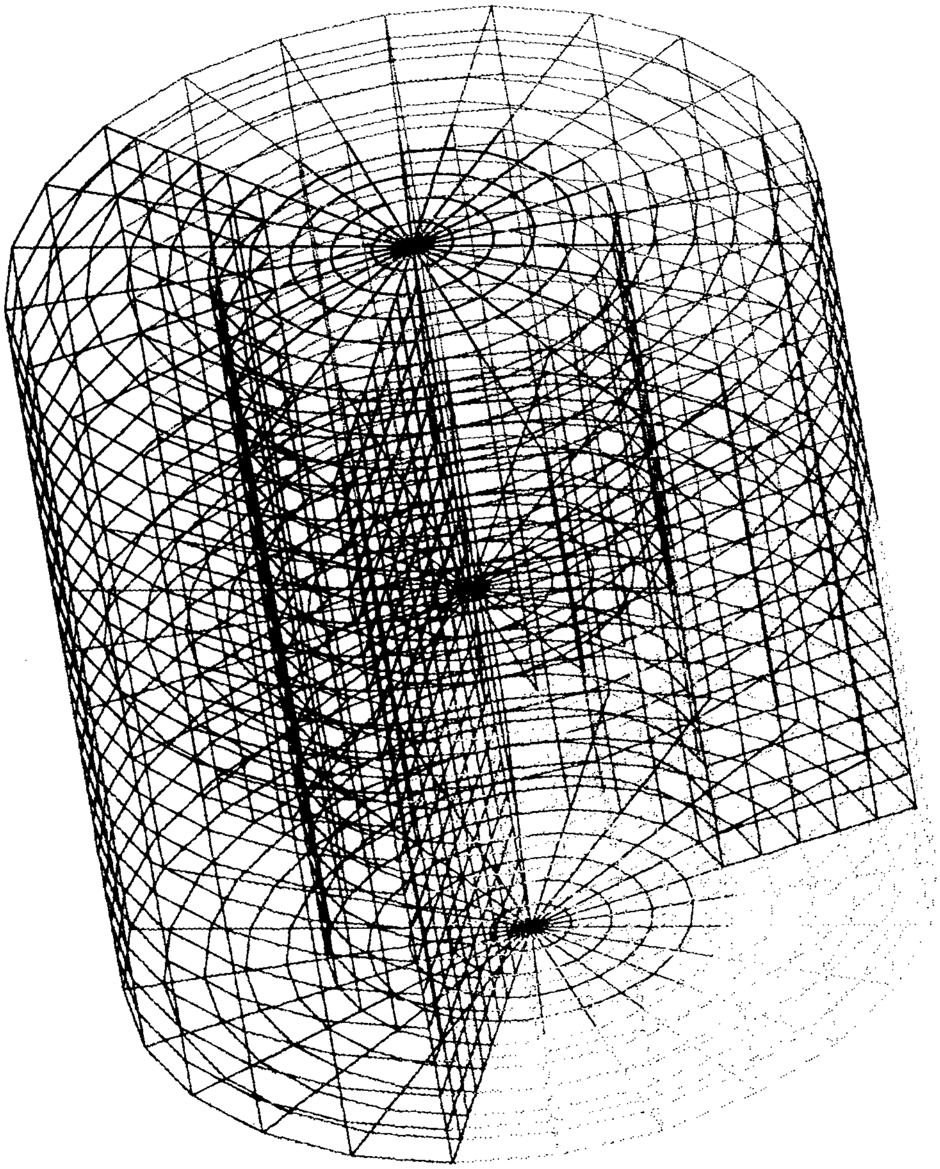

```
  0.31244123        0.62488246        0.93732369         2.8119686
   2.6557479         2.4995277         2.3433070         3.7492914
   1.0000000         1.0000000         1.0000000    /
'BCATR    RA' /
'G        RA'
          0.        0.13562261        0.12604296        0.11772902
          0.        0.30228546        0.28278044        0.26564652
          0.        0.35047242        0.33044401        0.31258577
          0.        0.40026557        0.37973812        0.36121699
          0.        0.21703082        0.20661046        0.19714551
          0.        0.12756790        0.27604079        0.31534517
  0.17311203        0.11088016        0.24146102        0.27818370
  0.15347512    0.98058343E-01        0.21459241        0.24886829
  0.13784339    0.87897301E-01        0.19311140        0.22514881
  0.12510394                0.                0.                0.
          0.        0.24659918        0.46935079        0.43723068
  0.20897944        0.44817868        0.85668629        0.80277795
  0.38507825        0.39297831        0.75527138        0.71308708
  0.34363681        0.34991074        0.67537630        0.64146173
  0.31026217        0.16286083        0.31511268        0.30031550
  0.14556657    0.52797659E-02    0.15093668E-01    0.23596969E-01
          0.    0.96469149E-02    0.19696908E-01    0.28563125E-01
          0.    0.12983790E-01    0.23274921E-01    0.32481741E-01
          0.    0.15616749E-01    0.26136102E-01    0.35652831E-01
          0.                0.                0.                0.
          0.    0.87141115E-02    0.18059509E-01    0.26184117E-01
          0.    0.13142128E-01    0.22772580E-01    0.31290554E-01
          0.    0.16545737E-01    0.26455153E-01    0.35338521E-01
          0.    0.19243797E-01    0.29412095E-01    0.38626384E-01
          0.                0.                0.                0.
          0.    0.68765525E-02    0.16766658E-01    0.25392342E-01
          0.    0.10853279E-01    0.20984415E-01    0.29967327E-01
          0.    0.13927292E-01    0.24296384E-01    0.33610038E-01
          0.    0.16374856E-01    0.26966259E-01    0.36579259E-01
          0.                0.                0.                0.
          0.    0.10329757E-01    0.19769274E-01    0.28027218E-01
          0.    0.14370628E-01    0.24095802E-01    0.32739241E-01
          0.    0.17511323E-01    0.27509574E-01    0.36507137E-01
          0.    0.20022707E-01    0.30272063E-01    0.39588995E-01
          0.                0.                0.                0.
          0.                0.                0.        0.14117190
  0.26904804        0.25109109        0.12014440        0.16478300
  0.31596917        0.29736680        0.14301823        0.18936056
  0.36481804        0.34560400        0.16689330        0.21460338
  0.41501385        0.39524019        0.19149148                0.
          0.                0.                0.        0.13315381
  0.15040128        0.17271157                0.        0.24229243
  0.27540445        0.31800097                0.        0.21277626
  0.24379474        0.28349376                0.        0.18968476
  0.21870694        0.25575459                0.    0.88346422E-01
  0.10223100        0.11993723                0.        0.95050633
  0.88468295        0.82740051                0.        0.82740051
  0.77709568        0.73256510                0.        0.73256516
  0.69286752        0.65725553                0.        0.65725553
  0.62512875        0.59599924                0.                0.
```

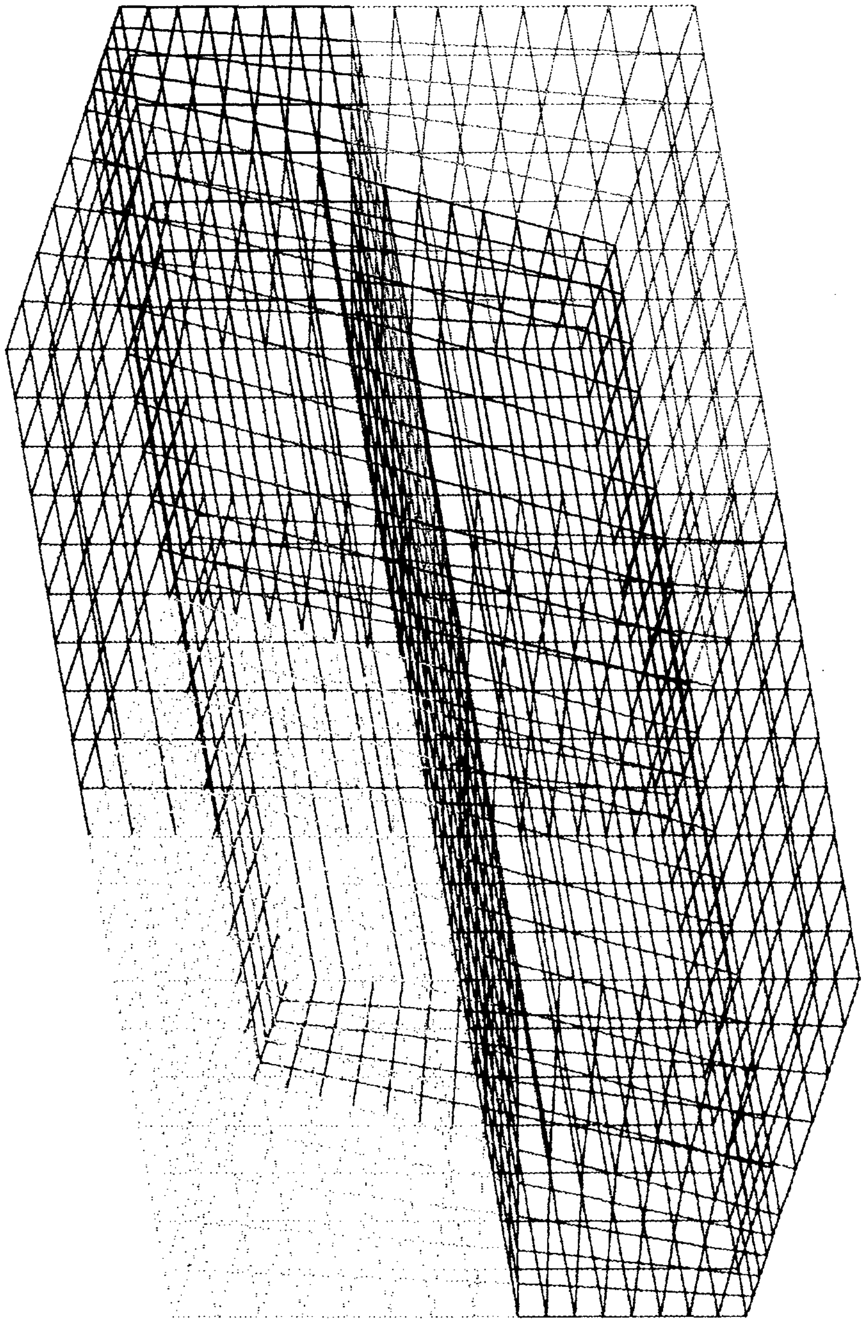
```
          0.               0.               0.               0.
 0.30593038       0.32473132       0.20854576       0.48012950E-01
 0.54157162       0.54670763       0.39796671       0.60968142E-01
 0.52928233       0.53493035       0.37037167       0.71258120E-01
 0.51665229       0.52230883       0.34456608               0.
 0.19473751       0.17818783       0.16423358               0.
 0.85601933E-01   0.16934255       0.17115526       0.87551482E-01
 0.93828052E-01   0.18485063       0.18577969       0.94712123E-01
 0.10380555       0.20349133       0.20314120       0.10314960
 0.11616143       0.22632293       0.22408919       0.11323925
          0.               0.               0.               0.
 0.92091545E-01   0.17636918       0.16570534       0.79612941E-01
 0.19561964       0.37365174       0.34978512       0.16768108
 0.21540448       0.40959638       0.38108227       0.18200326
 0.23965295       0.45321617       0.41854626       0.19900523
 0.12933931       0.24357727       0.22368029       0.10599522
 0.24160016E-01   0.14500412E-01   0.59848260E-02           0.
 0.27261153E-01   0.17353410E-01   0.87159229E-02           0.
 0.31010484E-01   0.20757731E-01   0.11937785E-01           0.
 0.35635237E-01   0.24890479E-01   0.15795879E-01           0.
          0.               0.               0.               0.
 0.20799736E-01   0.11545716E-01   0.33664375E-02           0.
 0.23801303E-01   0.14346307E-01   0.60781264E-02           0.
 0.27413668E-01   0.17674843E-01   0.92659742E-02           0.
 0.31844627E-01   0.21696309E-01   0.13067589E-01           0.
          0.               0.               0.               0.
 0.25132045E-01   0.15398369E-01   0.68475283E-02           0.
 0.28429007E-01   0.18419104E-01   0.97288489E-02           0.
 0.32439969E-01   0.22043003E-01   0.13143910E-01           0.
 0.37425354E-01   0.26470985E-01   0.17256310E-01           0.
          0.               0.               0.               0.
 0.21741915E-01   0.12428287E-01   0.42239549E-02           0.
 0.24928462E-01   0.15389841E-01   0.70816660E-02           0.
 0.28786210E-01   0.18927790E-01   0.10456304E-01           0.
 0.33552475E-01   0.23228746E-01   0.14502218E-01           0.
          0.               0.               0.               0.
          0.               0.       0.23652382       0.45271370
 0.42499834       0.20408922       0.22297814       0.42505112
 0.39680120       0.18989894       0.21049191       0.39928362
 0.37025982       0.17648107       0.19944446       0.37605128
 0.34588805       0.16406269               0.               0.
          0.               0.       0.84000833E-01   0.83497308E-01
 0.85846469E-01           0.       0.17830911       0.17655274
 0.18090251               0.       0.19611010       0.19290081
 0.19652231               0.       0.21787004       0.21259284
 0.21510009               0.       0.11745262       0.11390904
 0.11465577               0.       0.36967134       0.34631619
 0.32573897               0.       0.40477365       0.37693489
 0.35268220               0.       0.44725248       0.41350016
 0.38448983               0.       0.49971095       0.45793381
 0.42261168               0.               0.               0.
          0.               0.               0.       0.25101829
 0.22703321       0.21703082       0.10441992       0.42672572
 0.41134271       0.40026563       0.11965033       0.39198917
 0.37524801       0.35047242       0.13845769       0.36193302
```

```
 0.34340242       0.30228540               0.       0.11772901
 0.12604298       0.13562261               0.       0.12510394
 0.22514878       0.19311139       0.87897308E-01   0.13784339
 0.24886824       0.21459238       0.98058350E-01   0.15347511
 0.27818361       0.24146099       0.11088016       0.17311200
 0.31534508       0.27604076       0.12756790               0.
          0.               0.               0.       0.14556657
 0.30031550       0.31511268       0.16286083       0.31026217
 0.64146185       0.67537630       0.34991077       0.34363681
 0.71308726       0.75527143       0.39297831       0.38507825
 0.80277807       0.85668641       0.44817868       0.20897943
 0.43723068       0.46935084       0.24659918       0.39588984E-01
 0.30272054E-01   0.20022700E-01           0.       0.36507130E-01
 0.27509568E-01   0.17511318E-01           0.       0.32739226E-01
 0.24095787E-01   0.14370610E-01           0.       0.28027186E-01
 0.19769253E-01   0.10329731E-01           0.               0.
          0.               0.               0.       0.36579255E-01
 0.26966246E-01   0.16374853E-01           0.       0.33610035E-01
 0.24296375E-01   0.13927290E-01           0.       0.29967317E-01
 0.20984396E-01   0.10853268E-01           0.       0.25392320E-01
 0.16766634E-01   0.68765334E-02           0.               0.
          0.               0.               0.       0.38626377E-01
 0.29412081E-01   0.19243790E-01           0.       0.35338514E-01
 0.26455145E-01   0.16545730E-01           0.       0.31290531E-01
 0.22772554E-01   0.13142105E-01           0.       0.26184097E-01
 0.18059490E-01   0.87140938E-02           0.               0.
          0.               0.               0.       0.35652827E-01
 0.26136093E-01   0.15616746E-01           0.       0.32481737E-01
 0.23274915E-01   0.12983787E-01           0.       0.28563103E-01
 0.19696884E-01   0.96468963E-02           0.       0.23596952E-01
 0.15093651E-01   0.52797534E-02           0.               0.
          0.               0.               0.               0.
          0.       0.19149145       0.39524022       0.41501385
 0.21460335       0.16689332       0.34560406       0.36481807
 0.18936056       0.14301820       0.29736677       0.31596914
 0.16478300       0.12014439       0.25109109       0.26904801
 0.14117189               0.               0.               0.
          0.       0.11993718       0.10223097       0.88346422E-01
          0.       0.25575456       0.21870689       0.18968475
          0.       0.28349373       0.24379468       0.21277626
          0.       0.31800091       0.27540439       0.24229237
          0.       0.17271152       0.15040126       0.13315383
          0.       0.59599912       0.62512887       0.65725559
          0.       0.65725559       0.69286752       0.73256522
          0.       0.73256522       0.77709568       0.82740051
          0.       0.82740051       0.88468295       0.95050633
          0.               0.               0.               0.
          0.               0.       0.27702001       0.24944595
 0.19473751       0.13793741       0.44610208       0.43282947
 0.40386575       0.12256017       0.45792133       0.44500577
 0.42774636       0.10320056       0.46765578       0.45534754
 0.45402187               0.       0.20854579       0.22153068
 0.23624130               0.       0.11323925       0.22408916
 0.22632292       0.11616143       0.10314958       0.20314117
 0.20349130       0.10380554       0.94712108E-01   0.18577968
```

```
   0.18485060       0.93828052E-01   0.87551475E-01   0.17115524
   0.16934255       0.85601933E-01           0.               0.
           0.               0.       0.10599520       0.22368029
   0.24357723       0.12933931       0.19900520       0.41854623
   0.45321617       0.23965289       0.18200323       0.38108221
   0.40959638       0.21540444       0.16768107       0.34978512
   0.37365174       0.19561963       0.79612926E-01   0.16570534
   0.17636918       0.92091560E-01   0.14502170E-01   0.23228720E-01
   0.33552472E-01           0.       0.10456266E-01   0.18927768E-01
   0.28786212E-01           0.       0.70816306E-02   0.15389824E-01
   0.24928465E-01           0.       0.42239279E-02   0.12428278E-01
   0.21741930E-01           0.               0.               0.
           0.               0.       0.17256269E-01   0.26470970E-01
   0.37425354E-01           0.       0.13143875E-01   0.22042990E-01
   0.32439969E-01           0.       0.97288191E-02   0.18419094E-01
   0.28429013E-01           0.       0.68475059E-02   0.15398372E-01
   0.25132064E-01           0.               0.               0.
           0.               0.       0.13067546E-01   0.21696281E-01
   0.31844623E-01           0.       0.92659360E-02   0.17674817E-01
   0.27413674E-01           0.       0.60780938E-02   0.14346291E-01
   0.23801314E-01           0.       0.33664128E-02   0.11545709E-01
   0.20799754E-01           0.               0.               0.
           0.               0.       0.15795840E-01   0.24890466E-01
   0.35635237E-01           0.       0.11937751E-01   0.20757722E-01
   0.31010486E-01           0.       0.87158950E-02   0.17353404E-01
   0.27261158E-01           0.       0.59848046E-02   0.14500418E-01
   0.24160035E-01           0.               0.               0.
           0.               0.               0.               0.
   0.16406269       0.34588799       0.37605125       0.19944444
   0.17648107       0.37025976       0.39928356       0.21049190
   0.18989895       0.39680120       0.42505118       0.22297820
   0.20408925       0.42499840       0.45271382       0.23652393
           0.               0.               0.               0.
   0.11465574       0.11390901       0.11745261               0.
   0.21510005       0.21259281       0.21787001               0.
   0.19652227       0.19290078       0.19611007               0.
   0.18090250       0.17655274       0.17830913               0.
   0.85846454E-01   0.83497293E-01   0.84000841E-01           0.
   0.42261162       0.45793381       0.49971092               0.
   0.38448974       0.41350010       0.44725248               0.
   0.35268217       0.37693483       0.40477359               0.
   0.32573894       0.34631619       0.36967134    /
'B        RA' /
'C        RA' /
'D        RA' /
'COORDS   RA' /
```







J MIMDPIC test data examples

```
rfesunh% ~/3DPIC/MIMDPIC/xmimdpic test40.uif
 Type number of PROCESSES required, NPRES
      must be .LE. number nodes =  1
1
   NPRES input as   1
 CNOUT=o_test40p1
  End of MODIFY, MYPRES =  1
rfesunh%
```

```
o_test40
'NLRES  L  False for NEWRUN,True for RESET' F
test40
3-d particle lattice test
warm electron plasma
2 x 2 x 2 blocks of 4 x 4 x 4 elements
2 x 2 x 2 superparticles per element initially
'CHLAB5 A  **Label available to programmer           1.1 ' /
'NDIARY I  **Channel for diary                       1.2 ' /
'NIN    I  **Current input channel                   1.2 ' /
'NLEDGE I  **Channel for restart records             1.2 ' /
'NONLIN I  **Channel for input-output                1.2 ' /
'NOUT   I  **Current output channel                  1.2 ' /
'NPRINT I  **Channel for printed output              1.2 ' /
'NPUNCH I  **Channel for card output (or equivalent) 1.2 ' /
'NREC   I  **Current record number                   1.2 ' /
'NRUN   I  **Maximum number of steps                 1.2 ' 5
'NADUMP IA **Codes for array dumps                   1.9 ' /
'NPDUMP IA **Codes for dumping points                1.9 ' /
'NVDUMP IA **Codes for dumping arrays                1.9 ' /
'NLCHED L  **.TRUE. if class 0 report-head required  1.9 ' /
'NLHEAD LA **.TRUE. if class 1-9 report-heads required 1.9 ' /
'NLOMT1 LA **Class 1 subprogram selector             1.9 ' /
'NLOMT2 LA **Class 2 subprogram selector             1.9 '
12*F,1*T/
'NLOMT3 LA **Class 3 subprogram selector             1.9 ' /
'NLREPT L  **.TRUE. if report required               1.9 ' /
'CLIGHT R  *Speed of light (SI)                      2.1 ' /
'BAPLYD R  *applied B field (SI)                     2.2 ' 0.0
'BCATR  RA **array of boundary condition attributes  2.2 ' /
'EAPLYD R  *applied E field (SI)                     2.2 ' 0.0
'SPATR  RA *array of particle species attributes     2.2 ' 2E8/
'SURFZ  R  *surface impedance in Z0,s                2.2 ' /
'XLEN1  RA *dimension of block type 1                2.2 '
1.2E-4,1.2E-4,1.2E-4/
'XLEN2  RA *dimension of block type 2                2.2 ' /
'NB     IA *no of blocks in side for NCASE=2         2.2 '
2,2,2/
'NCASE  I  *select device initialisation case        2.2 ' 2
'NINIT  I  *select field initialisation              2.2 ' 4
'NODIM  I  *dimensionality of problem                2.2 ' 3
'NOEL1  IA *elements in block type 1 side            2.2 '
 4,4,4 /
'NOEL2  IA *elements in block type 2 side            2.2 ' /
'NPINIT I  *select particle initialisation           2.2 ' 4
'NSPEC  I  *number of particle species               2.2 ' 1
'COUR   R  *max courant number                       3.1 ' 0.95
'NBLOCK I  *number of blocks                         4.1 ' /
'MIMDOP I  **if =1, diagnosics for MIMD, =2 for XPATCH 5.1 ' /
'NGMAX  I  *Max no of grid file frames               5.1 ' /
'NOPSEL I  **Select Output Sequence                  5.1 ' 3
'NS1    I  **output every NS1 steps                  5.1 ' /
'NXPTDD I  **select 0.4 EXPERT diagnostic dump       5.1 ' 3
```

g_test40p1

3-d particle lattice test

warm electron plasma

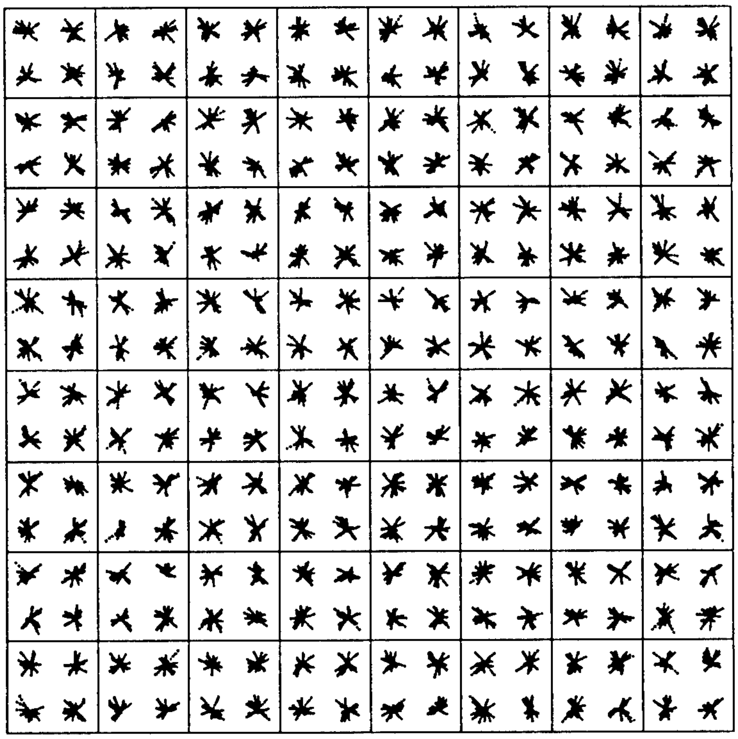
2 x 2 x 2 blocks of 4 x 4 x 4 elements

2 x 2 x 2 superparticles per element initially

Date: 22-09-94

Time: 14:33:14

Ref: test40



Time = 0.000 ns   Step = 0   test40   J W Eastwood   Frame 2

K PIC3D test data examples

```
   NSTEP     =          50
   ICLP      =       20102


   BLOCK     =           1



d Component 1



 Slice at 3 index =  0

       17  2.3590E-02  2.3434E-02  9.1343E-03  0.0000E+00
       13  1.6075E-02  1.1697E-02  5.8073E-03  0.0000E+00
        9  2.5260E-02  1.2852E-02 -9.5317E-03  0.0000E+00
        5 -2.3010E-02 -7.1974E-03 -2.3700E-02  0.0000E+00
        1  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  1

       37  2.3598E-02  2.3483E-02  9.1705E-03  0.0000E+00
       33  1.6136E-02  1.1757E-02  5.7963E-03  0.0000E+00
       29  2.5204E-02  1.2824E-02 -9.5730E-03  0.0000E+00
       25 -2.2956E-02 -7.3005E-03 -2.3727E-02  0.0000E+00
       21  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  2

       57  2.3502E-02  2.3438E-02  9.1515E-03  0.0000E+00
       53  1.6086E-02  1.1743E-02  5.8454E-03  0.0000E+00
       49  2.5199E-02  1.2884E-02 -9.6612E-03  0.0000E+00
       45 -2.2899E-02 -7.3217E-03 -2.3600E-02  0.0000E+00
       41  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  3

       77  2.3537E-02  2.3422E-02  9.1858E-03  0.0000E+00
       73  1.6128E-02  1.1734E-02  5.8289E-03  0.0000E+00
       69  2.5160E-02  1.2842E-02 -9.5829E-03  0.0000E+00
       65 -2.2926E-02 -7.2200E-03 -2.3648E-02  0.0000E+00
       61  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  4

       97  2.3609E-02  2.3438E-02  9.1515E-03  0.0000E+00
       93  1.6087E-02  1.1700E-02  5.7900E-03  0.0000E+00
       89  2.5188E-02  1.2827E-02 -9.5604E-03  0.0000E+00
       85 -2.2951E-02 -7.2359E-03 -2.3686E-02  0.0000E+00
       81  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  5

      117  2.3560E-02  2.3399E-02  9.1286E-03  0.0000E+00
```

```
      113  1.6093E-02  1.1704E-02  5.8003E-03  0.0000E+00
      109  2.5238E-02  1.2861E-02 -9.5337E-03  0.0000E+00
      105 -2.2983E-02 -7.2239E-03 -2.3685E-02  0.0000E+00
      101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00


d Component 2



 Slice at 3 index =  0

      137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      133  0.0000E+00 -8.3485E-03  8.7433E-03 -7.9002E-03
      129  0.0000E+00 -1.2735E-02  2.8210E-03  3.8643E-03
      125  0.0000E+00 -2.5127E-02 -1.9562E-02 -1.7756E-02
      121  0.0000E+00 -9.3250E-03 -3.6057E-02 -3.8002E-02

 Slice at 3 index =  1

      157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      153  0.0000E+00 -8.3122E-03  8.7509E-03 -7.9308E-03
      149  0.0000E+00 -1.2684E-02  2.7924E-03  3.8376E-03
      145  0.0000E+00 -2.5066E-02 -1.9585E-02 -1.7742E-02
      141  0.0000E+00 -9.4032E-03 -3.6007E-02 -3.7991E-02

 Slice at 3 index =  2

      177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      173  0.0000E+00 -8.2855E-03  8.7776E-03 -7.9079E-03
      169  0.0000E+00 -1.2672E-02  2.8801E-03  3.7689E-03
      165  0.0000E+00 -2.4971E-02 -1.9684E-02 -1.7708E-02
      161  0.0000E+00 -9.3994E-03 -3.5954E-02 -3.8067E-02

 Slice at 3 index =  3

      197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      193  0.0000E+00 -8.3199E-03  8.7662E-03 -7.8964E-03
      189  0.0000E+00 -1.2688E-02  2.8572E-03  3.8643E-03
      185  0.0000E+00 -2.5028E-02 -1.9562E-02 -1.7757E-02
      181  0.0000E+00 -9.3307E-03 -3.5988E-02 -3.8021E-02

 Slice at 3 index =  4

      217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      213  0.0000E+00 -8.3656E-03  8.7433E-03 -7.9002E-03
      209  0.0000E+00 -1.2741E-02  2.8572E-03  3.8261E-03
      205  0.0000E+00 -2.5105E-02 -1.9558E-02 -1.7712E-02
      201  0.0000E+00 -9.3880E-03 -3.5980E-02 -3.8025E-02

 Slice at 3 index =  5

      237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      233  0.0000E+00 -8.3389E-03  8.7566E-03 -7.8621E-03
      229  0.0000E+00 -1.2728E-02  2.8400E-03  3.8624E-03
      225  0.0000E+00 -2.5105E-02 -1.9556E-02 -1.7708E-02
      221  0.0000E+00 -9.3670E-03 -3.5997E-02 -3.7989E-02



d Component  3



 Slice at  3  index =   0

      257  0.0000E+00  1.0563E-05 -7.0331E-07 -9.3077E-06
      253  0.0000E+00 -1.4534E-05 -1.2733E-05 -1.4362E-06
      249  0.0000E+00  5.4181E-06  2.3252E-06  7.2280E-06
      245  0.0000E+00 -7.3023E-06  6.9470E-06  9.9580E-07
      241  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at  3  index =   1

      277  0.0000E+00 -5.3998E-06  1.1984E-05 -1.2800E-05
      273  0.0000E+00 -1.7217E-06  7.2605E-06  3.4791E-07
      269  0.0000E+00  7.7248E-06  5.9888E-06 -1.9439E-06
      265  0.0000E+00  5.7657E-07 -1.0999E-05 -1.1788E-05
      261  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at  3  index =   2

      297  0.0000E+00  1.1766E-05 -3.3839E-06  9.7668E-06
      293  0.0000E+00 -7.8928E-06 -1.0992E-05  9.3447E-07
      289  0.0000E+00  7.6645E-07 -7.7554E-07 -2.3279E-06
      285  0.0000E+00 -1.7180E-07 -4.8406E-06  6.6043E-06
      281  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at  3  index =   3

      317  0.0000E+00 -4.4357E-06 -1.2753E-05 -7.6398E-06
      313  0.0000E+00  3.2161E-06  1.3001E-05  2.0941E-06
      309  0.0000E+00 -7.9456E-06  4.1321E-06  3.7536E-06
      305  0.0000E+00 -1.7754E-06  7.8650E-06  1.3505E-06
      301  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at  3  index =   4

      337  0.0000E+00 -1.4462E-05 -7.5565E-06  2.1484E-05
      333  0.0000E+00  1.7074E-05  1.0379E-05 -2.0085E-06
      329  0.0000E+00  4.5058E-06 -9.3175E-06 -1.9219E-05
      325  0.0000E+00  8.0654E-06  2.0361E-07 -2.0935E-06
      321  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at  3  index =   5

      357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      353  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      349  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
```

```
      345  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      341  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



  BLOCK     =            1



b Component  1



 Slice at  3  index =   0

       17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       13  0.0000E+00  5.9115E-06 -1.0409E-05 -1.5438E-06
        9  0.0000E+00  1.2441E-05 -8.5281E-06  7.5533E-06
        5  0.0000E+00 -7.0347E-06 -1.2099E-05 -1.0080E-05
        1  0.0000E+00 -8.5744E-06 -1.2081E-06 -1.7989E-05

 Slice at  3  index =   1

       37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       33  0.0000E+00  8.2917E-06 -1.8098E-06  2.4273E-05
       29  0.0000E+00  1.1317E-05  1.1271E-05 -1.3526E-05
       25  0.0000E+00  3.5762E-05 -7.9750E-06  1.5124E-05
       21  0.0000E+00  2.4761E-05 -1.8262E-06  2.2005E-05

 Slice at  3  index =   2

       57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       53  0.0000E+00 -2.6598E-05 -1.0252E-05  1.8100E-05
       49  0.0000E+00  4.8530E-06  2.3678E-05  1.4472E-05
       45  0.0000E+00 -1.5521E-06  2.5508E-05  2.1632E-07
       41  0.0000E+00  6.0015E-06  6.0149E-05  1.3017E-05

 Slice at  3  index =   3

       77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       73  0.0000E+00  1.3136E-05  3.3528E-05 -3.2977E-05
       69  0.0000E+00  2.4737E-06 -5.5511E-06 -1.4141E-05
       65  0.0000E+00  3.5186E-06  6.6602E-07  1.9887E-06
       61  0.0000E+00  8.3948E-06 -9.9097E-06 -1.1895E-05

 Slice at  3  index =   4

       97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       93  0.0000E+00  2.9163E-05 -9.8315E-06 -1.7892E-07
       89  0.0000E+00  9.0142E-06  9.2932E-07 -2.5284E-05
       85  0.0000E+00 -8.6129E-06  6.9385E-06 -3.4475E-06
       81  0.0000E+00 -6.6003E-06 -2.5664E-05 -2.2041E-06

 Slice at  3  index =   5
```

```
      117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      113  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      109  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      105  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component  2



 Slice at 3 index =   0

      137  2.8842E-05 -4.5558E-05 -2.9229E-05  0.0000E+00
      133 -5.6342E-05 -2.6011E-05  3.8364E-06  0.0000E+00
      129  1.2619E-05  2.9334E-05  2.5043E-05  0.0000E+00
      125  6.9113E-06  3.8865E-05  2.7101E-05  0.0000E+00
      121  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =   1

      157  6.2694E-05  2.6226E-06 -1.1902E-05  0.0000E+00
      153 -3.6783E-06 -1.4654E-05 -3.9347E-05  0.0000E+00
      149  1.7799E-05 -2.9670E-05  3.8985E-06  0.0000E+00
      145 -8.7623E-06  2.3937E-06 -1.9254E-05  0.0000E+00
      141  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =   2

      177  4.6110E-06  4.2945E-05 -3.8808E-06  0.0000E+00
      173 -1.6198E-05  2.3178E-05 -1.0853E-05  0.0000E+00
      169  1.3630E-05 -3.8110E-06 -1.8616E-05  0.0000E+00
      165 -1.3115E-05 -3.6114E-05 -2.1935E-05  0.0000E+00
      161  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =   3

      197 -5.2063E-05  6.2026E-06  2.5633E-05  0.0000E+00
      193  4.1622E-05 -5.9535E-06  1.7007E-05  0.0000E+00
      189 -1.0497E-05  8.6999E-06 -1.2805E-05  0.0000E+00
      185  6.0764E-06 -6.5062E-06  8.9733E-06  0.0000E+00
      181  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =   4

      217 -5.5148E-05 -3.0408E-05  3.1359E-05  0.0000E+00
      213 -2.8387E-06  5.6368E-06 -4.4247E-06  0.0000E+00
      209 -5.8506E-06 -4.4801E-06 -1.5618E-06  0.0000E+00
      205 -1.6215E-05 -2.4615E-06  1.3434E-05  0.0000E+00
      201  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =   5
```

```
      237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      233  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      229  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      225  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      221  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component  3



 Slice at 3 index =   0

      257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      253  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
      249  8.0146E+01  8.4733E+01  8.9319E+01  0.0000E+00
      245  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
      241  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00

 Slice at 3 index =   1

      277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      273  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
      269  8.0146E+01  8.4734E+01  8.9319E+01  0.0000E+00
      265  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
      261  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00

 Slice at 3 index =   2

      297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      293  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
      289  8.0146E+01  8.4734E+01  8.9319E+01  0.0000E+00
      285  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
      281  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00

 Slice at 3 index =   3

      317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      313  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
      309  8.0146E+01  8.4733E+01  8.9319E+01  0.0000E+00
      305  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
      301  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00

 Slice at 3 index =   4

      337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      333  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
      329  8.0146E+01  8.4733E+01  8.9319E+01  0.0000E+00
      325  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
      321  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00

 Slice at 3 index =   5

      357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      353  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
      349  8.0146E+01  8.4733E+01  8.9319E+01  0.0000E+00
      345  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
      341  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00



   BLOCK     =             2



d Component 1



 Slice at 3 index =  0

       17 -7.2403E-03 -4.1113E-02 -3.8870E-02  0.0000E+00
       13  1.7580E-02 -1.5354E-02 -9.5509E-02  0.0000E+00
        9 -3.1164E-02 -1.0221E-02  1.7341E-02  0.0000E+00
        5 -4.3956E-02  1.8974E-02  4.2700E-02  0.0000E+00
        1  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  1

       37 -7.2403E-03 -4.1126E-02 -3.8872E-02  0.0000E+00
       33  1.7555E-02 -1.5373E-02 -9.5471E-02  0.0000E+00
       29 -3.1139E-02 -1.0166E-02  1.7340E-02  0.0000E+00
       25 -4.3960E-02  1.8963E-02  4.2693E-02  0.0000E+00
       21  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  2

       57 -7.2441E-03 -4.1107E-02 -3.8872E-02  0.0000E+00
       53  1.7539E-02 -1.5346E-02 -9.5530E-02  0.0000E+00
       49 -3.1143E-02 -1.0218E-02  1.7359E-02  0.0000E+00
       45 -4.3969E-02  1.8957E-02  4.2672E-02  0.0000E+00
       41  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  3

       77 -7.2098E-03 -4.1111E-02 -3.8822E-02  0.0000E+00
       73  1.7554E-02 -1.5347E-02 -9.5480E-02  0.0000E+00
       69 -3.1156E-02 -1.0255E-02  1.7328E-02  0.0000E+00
       65 -4.3986E-02  1.8928E-02  4.2707E-02  0.0000E+00
       61  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  4

       97 -7.2212E-03 -4.1092E-02 -3.8864E-02  0.0000E+00
       93  1.7530E-02 -1.5376E-02 -9.5499E-02  0.0000E+00
       89 -3.1112E-02 -1.0159E-02  1.7338E-02  0.0000E+00
       85 -4.3978E-02  1.8901E-02  4.2695E-02  0.0000E+00
       81  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
```

```
 Slice at 3 index =  5

      117 -7.1964E-03 -4.1142E-02 -3.8887E-02  0.0000E+00
      113  1.7543E-02 -1.5319E-02 -9.5449E-02  0.0000E+00
      109 -3.1131E-02 -1.0194E-02  1.7317E-02  0.0000E+00
      105 -4.3964E-02  1.8918E-02  4.2696E-02  0.0000E+00
      101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00


d Component 2



 Slice at 3 index =  0

      137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      133 -7.9002E-03 -2.2203E-02  2.2120E-02  0.0000E+00
      129  3.8643E-03 -5.5140E-02 -5.8020E-02  0.0000E+00
      125 -1.7756E-02 -3.4178E-02 -3.0493E-02  0.0000E+00
      121 -3.8002E-02  2.8740E-02 -6.7482E-03  0.0000E+00

 Slice at 3 index =  1

      157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      153 -7.9308E-03 -2.2247E-02  2.2114E-02  0.0000E+00
      149  3.8376E-03 -5.5180E-02 -5.7995E-02  0.0000E+00
      145 -1.7742E-02 -3.4199E-02 -3.0483E-02  0.0000E+00
      141 -3.7991E-02  2.8748E-02 -6.7635E-03  0.0000E+00

 Slice at 3 index =  2

      177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      173 -7.9079E-03 -2.2236E-02  2.2141E-02  0.0000E+00
      169  3.7689E-03 -5.5138E-02 -5.8033E-02  0.0000E+00
      165 -1.7708E-02 -3.4187E-02 -3.0460E-02  0.0000E+00
      161 -3.8067E-02  2.8744E-02 -6.7711E-03  0.0000E+00

 Slice at 3 index =  3

      197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      193 -7.8964E-03 -2.2205E-02  2.2099E-02  0.0000E+00
      189  3.8643E-03 -5.5126E-02 -5.8044E-02  0.0000E+00
      185 -1.7757E-02 -3.4222E-02 -3.0495E-02  0.0000E+00
      181 -3.8021E-02  2.8656E-02 -6.6605E-03  0.0000E+00

 Slice at 3 index =  4

      217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      213 -7.9002E-03 -2.2232E-02  2.2133E-02  0.0000E+00
      209  3.8261E-03 -5.5138E-02 -5.7991E-02  0.0000E+00
      205 -1.7712E-02 -3.4191E-02 -3.0476E-02  0.0000E+00
      201 -3.8025E-02  2.8709E-02 -6.6757E-03  0.0000E+00
 Slice at 3 index =  5

      237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      233 -7.8621E-03 -2.2261E-02  2.2131E-02  0.0000E+00
      229  3.8624E-03 -5.5130E-02 -5.8001E-02  0.0000E+00
      225 -1.7708E-02 -3.4166E-02 -3.0506E-02  0.0000E+00
      221 -3.7989E-02  2.8702E-02 -6.7368E-03  0.0000E+00



d Component 3



 Slice at 3 index =  0

      257 -9.3077E-06  2.0829E-06  4.3478E-06  0.0000E+00
      253 -1.4362E-06  1.1316E-05  1.6172E-06  0.0000E+00
      249  7.2280E-06  6.5683E-06 -2.7515E-05  0.0000E+00
      245  9.9580E-07 -1.5060E-05  1.0041E-05  0.0000E+00
      241  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  1

      277 -1.2800E-05 -8.6135E-07 -8.4419E-07  0.0000E+00
      273  3.4791E-07  1.2620E-06 -9.1454E-06  0.0000E+00
      269 -1.9439E-06 -1.3162E-05  1.1767E-05  0.0000E+00
      265 -1.1788E-05  1.7679E-06  2.3506E-06  0.0000E+00
      261  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  2

      297  9.7668E-06 -8.1744E-06  1.1997E-06  0.0000E+00
      293  9.3447E-07 -4.8979E-06  6.4500E-07  0.0000E+00
      289 -2.3279E-06  7.1267E-06 -5.0415E-06  0.0000E+00
      285  6.6043E-06  1.5467E-05 -2.4098E-05  0.0000E+00
      281  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  3

      317 -7.6398E-06  7.6069E-06 -1.9826E-06  0.0000E+00
      313  2.0941E-06  1.1411E-06 -6.1600E-06  0.0000E+00
      309  3.7536E-06 -1.0749E-06 -6.4706E-06  0.0000E+00
      305  1.3505E-06 -1.5220E-05  1.4020E-05  0.0000E+00
      301  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  4

      337  2.1484E-05 -8.6043E-06 -1.6028E-07  0.0000E+00
      333 -2.0085E-06 -1.1890E-05 -2.3829E-06  0.0000E+00
      329 -1.9219E-05 -4.2418E-06  1.8371E-05  0.0000E+00
      325 -2.0935E-06  1.6640E-05  1.2190E-06  0.0000E+00
      321  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  5
```

```
      357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      353  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      349  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      345  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      341  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



   BLOCK    =            2



b Component 1



 Slice at 3 index =  0

       17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       13 -1.5443E-06 -1.3463E-06  1.1901E-05  0.0000E+00
        9  7.5570E-06 -2.7204E-05  8.3145E-06  0.0000E+00
        5 -1.0080E-05 -1.4255E-05 -2.3994E-05  0.0000E+00
        1 -1.7991E-05  1.8662E-05  7.5844E-07  0.0000E+00

 Slice at 3 index =  1

       37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       33  2.4273E-05 -8.2709E-06  1.2770E-05  0.0000E+00
       29 -1.3526E-05 -7.2913E-07 -5.5200E-06  0.0000E+00
       25  1.5124E-05 -1.8218E-05  1.8138E-05  0.0000E+00
       21  2.2005E-05 -1.5842E-05 -2.9938E-06  0.0000E+00

 Slice at 3 index =  2

       57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       53  1.8100E-05  6.8842E-06 -2.1031E-05  0.0000E+00
       49  1.4472E-05 -2.5485E-05  2.1236E-05  0.0000E+00
       45  2.1632E-07  7.8531E-06 -7.6958E-06  0.0000E+00
       41  1.3017E-05 -3.9233E-05  1.0247E-05  0.0000E+00

 Slice at 3 index =  3

       77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       73 -3.2977E-05  2.0078E-06  8.1793E-06  0.0000E+00
       69 -1.4141E-05  3.0097E-05 -1.7413E-05  0.0000E+00
       65  1.9887E-06  3.3486E-06  1.1041E-05  0.0000E+00
       61 -1.1895E-05  7.8202E-07  4.2604E-06  0.0000E+00

 Slice at 3 index =  4

       97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       93 -1.8055E-07 -3.6579E-06 -2.3740E-05  0.0000E+00
       89 -2.5282E-05  6.6864E-06  1.8884E-05  0.0000E+00
       85 -3.4503E-06 -8.1065E-06  4.0565E-07  0.0000E+00
       81 -2.2060E-06  1.5862E-05 -3.8346E-05  0.0000E+00

 Slice at 3 index =  5

      117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      113  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      109  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      105  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component  2



 Slice at 3 index =  0

      137  1.9155E-06  1.4029E-05 -4.5247E-05  0.0000E+00
      133  6.9989E-07  3.1239E-05 -2.4401E-06  0.0000E+00
      129  4.5273E-05 -4.2378E-05  7.4819E-05  0.0000E+00
      125  4.9965E-05 -4.6115E-05 -7.0041E-05  0.0000E+00
      121  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  1

      157 -1.3671E-05 -9.0376E-06  9.0478E-06  0.0000E+00
      153  1.7657E-05  1.9366E-05  3.8192E-05  0.0000E+00
      149 -2.0755E-05 -7.4198E-06 -6.7472E-05  0.0000E+00
      145 -3.7733E-05  1.7763E-05  4.1716E-05  0.0000E+00
      141  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  2

      177 -3.6155E-05  7.8622E-06 -2.4638E-05  0.0000E+00
      173  1.3790E-05  4.3451E-05 -2.8461E-06  0.0000E+00
      169  2.0908E-05  2.8737E-05  7.7835E-06  0.0000E+00
      165 -3.4545E-05  1.3844E-05  1.4901E-06  0.0000E+00
      161  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  3

      197  1.9348E-05 -5.0608E-06 -2.3330E-06  0.0000E+00
      193  1.3106E-05 -3.1372E-05  7.9125E-06  0.0000E+00
      189 -5.1478E-05 -1.6738E-05  1.2373E-05  0.0000E+00
      185  2.8774E-05  4.5595E-05  2.9335E-05  0.0000E+00
      181  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  4

      217  2.5312E-05 -1.9461E-05  4.3607E-05  0.0000E+00
      213  1.0578E-05 -3.8098E-05 -5.4158E-05  0.0000E+00
      209 -5.2378E-05  6.4764E-06  1.5382E-05  0.0000E+00
      205  9.1903E-06 -1.6757E-05  8.1398E-06  0.0000E+00
```

```
      201  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  5

      237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      233  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      229  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      225  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      221  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component  3



 Slice at 3 index =  0

      257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      253  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
      249  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
      245  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
      241  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00

 Slice at 3 index =  1

      277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      273  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
      269  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
      265  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
      261  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00

 Slice at 3 index =  2

      297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      293  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
      289  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
      285  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
      281  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00

 Slice at 3 index =  3

      317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      313  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
      309  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
      305  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
      301  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00

 Slice at 3 index =  4

      337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      333  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
      329  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
      325  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
      321  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00
 Slice at  3 index =   5

       357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       353  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
       349  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
       345  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
       341  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00



   BLOCK     =            3



d Component  1



 Slice at  3 index =   0

        17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        13 -6.2618E-04  2.5171E-02  4.7899E-02  0.0000E+00
         9 -1.5464E-02 -2.4732E-02  1.3765E-02  0.0000E+00
         5  2.9552E-02  2.0175E-02 -8.0556E-03  0.0000E+00
         1 -7.2403E-03 -4.1113E-02 -3.8870E-02  0.0000E+00

 Slice at  3 index =   1

        37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        33 -5.9616E-04  2.5143E-02  4.7886E-02  0.0000E+00
        29 -1.5466E-02 -2.4691E-02  1.3779E-02  0.0000E+00
        25  2.9599E-02  2.0169E-02 -8.0923E-03  0.0000E+00
        21 -7.2403E-03 -4.1126E-02 -3.8872E-02  0.0000E+00

 Slice at  3 index =   2

        57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        53 -6.5596E-04  2.5178E-02  4.7799E-02  0.0000E+00
        49 -1.5374E-02 -2.4700E-02  1.3772E-02  0.0000E+00
        45  2.9591E-02  2.0184E-02 -8.0545E-03  0.0000E+00
        41 -7.2441E-03 -4.1107E-02 -3.8872E-02  0.0000E+00

 Slice at  3 index =   3

        77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        73 -6.3890E-04  2.5132E-02  4.7912E-02  0.0000E+00
        69 -1.5391E-02 -2.4639E-02  1.3740E-02  0.0000E+00
        65  2.9562E-02  2.0155E-02 -8.1085E-03  0.0000E+00
        61 -7.2098E-03 -4.1111E-02 -3.8822E-02  0.0000E+00

 Slice at  3 index =   4

        97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
```

```
        93 -6.1022E-04  2.5185E-02  4.7866E-02  0.0000E+00
        89 -1.5456E-02 -2.4714E-02  1.3751E-02  0.0000E+00
        85  2.9583E-02  2.0207E-02 -8.0426E-03  0.0000E+00
        81 -7.2212E-03 -4.1092E-02 -3.8864E-02  0.0000E+00

 Slice at  3 index =   5

       117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       113 -6.3543E-04  2.5216E-02  4.7881E-02  0.0000E+00
       109 -1.5457E-02 -2.4711E-02  1.3813E-02  0.0000E+00
       105  2.9572E-02  2.0161E-02 -8.0792E-03  0.0000E+00
       101 -7.1964E-03 -4.1142E-02 -3.8887E-02  0.0000E+00



d Component  2



 Slice at  3 index =   0

       137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       133  2.5877E-02  4.5319E-03 -1.3128E-02  0.0000E+00
       129  7.6885E-03  3.0287E-02  9.6226E-03  0.0000E+00
       125 -8.3218E-03  2.1040E-02  4.8126E-02  0.0000E+00
       121  8.4610E-03  1.1646E-02  1.9890E-02  0.0000E+00

 Slice at  3 index =   1

       157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       153  2.5860E-02  4.5357E-03 -1.3062E-02  0.0000E+00
       149  7.6981E-03  3.0315E-02  9.6359E-03  0.0000E+00
       145 -8.3351E-03  2.1034E-02  4.8134E-02  0.0000E+00
       141  8.4763E-03  1.1627E-02  1.9852E-02  0.0000E+00

 Slice at  3 index =   2

       177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       173  2.5879E-02  4.5357E-03 -1.3016E-02  0.0000E+00
       169  7.5722E-03  3.0342E-02  9.6512E-03  0.0000E+00
       165 -8.3313E-03  2.1042E-02  4.8134E-02  0.0000E+00
       161  8.4953E-03  1.1639E-02  1.9882E-02  0.0000E+00

 Slice at  3 index =   3

       197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       193  2.5829E-02  4.5471E-03 -1.3046E-02  0.0000E+00
       189  7.5569E-03  3.0323E-02  9.7122E-03  0.0000E+00
       185 -8.3313E-03  2.1072E-02  4.8092E-02  0.0000E+00
       181  8.4877E-03  1.1665E-02  1.9875E-02  0.0000E+00

 Slice at  3 index =   4

       217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       213  2.5818E-02  4.4861E-03 -1.3020E-02  0.0000E+00
```

```
      209  7.6447E-03  3.0312E-02  9.6626E-03  0.0000E+00
      205 -8.3618E-03  2.1030E-02  4.8149E-02  0.0000E+00
      201  8.4915E-03  1.1646E-02  1.9886E-02  0.0000E+00

 Slice at 3 index =  5

      237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      233  2.5862E-02  4.5204E-03 -1.3094E-02  0.0000E+00
      229  7.6370E-03  3.0342E-02  9.6092E-03  0.0000E+00
      225 -8.3656E-03  2.1097E-02  4.8115E-02  0.0000E+00
      221  8.4496E-03  1.1667E-02  1.9876E-02  0.0000E+00



d Component 3



 Slice at 3 index =  0

      257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      253 -7.5168E-06 -1.2109E-05  1.5264E-06  0.0000E+00
      249 -1.7402E-06  5.4475E-06 -2.0405E-07  0.0000E+00
      245  1.4431E-05  1.5761E-06 -2.8648E-06  0.0000E+00
      241 -9.3077E-06  2.0829E-06  4.3478E-06  0.0000E+00

 Slice at 3 index =  1

      277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      273 -1.4240E-05  2.0173E-05 -1.2174E-05  0.0000E+00
      269  1.4355E-05 -1.1976E-05 -5.1697E-06  0.0000E+00
      265 -1.7464E-06 -3.0805E-06  1.6027E-05  0.0000E+00
      261 -1.2800E-05 -8.6135E-07 -8.4419E-07  0.0000E+00

 Slice at 3 index =  2

      297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      293  4.1083E-06 -3.9172E-06  1.7832E-05  0.0000E+00
      289 -5.1041E-07  8.3458E-06 -5.7274E-06  0.0000E+00
      285  6.7813E-06 -1.4966E-06 -1.9673E-05  0.0000E+00
      281  9.7668E-06 -8.1744E-06  1.1997E-06  0.0000E+00

 Slice at 3 index =  3

      317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      313  6.6768E-06 -5.7511E-07 -1.0790E-05  0.0000E+00
      309 -1.8278E-06  7.0660E-06  4.9968E-06  0.0000E+00
      305 -2.8450E-06 -8.3442E-06  4.2076E-06  0.0000E+00
      301 -7.6398E-06  7.6069E-06 -1.9826E-06  0.0000E+00

 Slice at 3 index =  4

      337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      333  6.6375E-06  3.2819E-06  1.8621E-06  0.0000E+00
      329 -1.3571E-05 -5.9034E-07  1.3848E-05  0.0000E+00
```

```
      325 -7.3097E-06  2.4366E-06 -5.5078E-06  0.0000E+00
      321  2.1484E-05 -8.6043E-06 -1.6028E-07  0.0000E+00

 Slice at 3 index =  5

      357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      353  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      349  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      345  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      341  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



   BLOCK     =            3



b Component 1



 Slice at 3 index =  0

       17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       13 -7.1655E-06 -9.7379E-06  8.3286E-06  0.0000E+00
        9  8.1657E-06  1.0721E-05 -4.3695E-05  0.0000E+00
        5  3.2179E-05 -1.4399E-05 -1.2253E-05  0.0000E+00
        1  1.0175E-05 -4.4793E-06 -1.1895E-05  0.0000E+00

 Slice at 3 index =  1

       37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       33 -5.3578E-06  5.3038E-05 -1.4849E-05  0.0000E+00
       29 -1.2215E-05  3.3013E-06  2.6180E-05  0.0000E+00
       25 -2.6015E-05  4.0845E-05  8.3465E-06  0.0000E+00
       21 -1.8861E-06  9.6181E-07  1.9354E-05  0.0000E+00

 Slice at 3 index =  2

       57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       53 -1.1652E-05 -1.3093E-06  1.7381E-05  0.0000E+00
       49  1.7279E-05 -4.2881E-06 -1.4760E-05  0.0000E+00
       45  2.1840E-05 -1.5955E-05  1.5882E-05  0.0000E+00
       41  2.0757E-05  4.9269E-06 -9.4243E-06  0.0000E+00

 Slice at 3 index =  3

       77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       73  1.0508E-05 -2.4501E-05 -3.6941E-06  0.0000E+00
       69 -6.6537E-06  1.0299E-05  1.6771E-05  0.0000E+00
       65 -1.8759E-05 -1.4208E-05 -3.4069E-05  0.0000E+00
       61 -1.5630E-05 -9.4284E-07  4.4771E-07  0.0000E+00

 Slice at 3 index =  4
```

```
      97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      93 -1.3586E-05 -3.3011E-05  8.0000E-06  0.0000E+00
      89 -9.6090E-06 -7.9041E-06  1.5892E-05  0.0000E+00
      85 -7.0042E-06 -9.5486E-06  2.9793E-05  0.0000E+00
      81 -1.8974E-05 -4.9315E-06 -4.7320E-07  0.0000E+00

 Slice at 3 index =  5

     117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     113  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     109  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     105  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component 2



 Slice at 3 index =  0

     137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     133 -4.6180E-05 -5.0189E-06  3.2892E-05  0.0000E+00
     129  4.0557E-05 -1.5795E-05 -3.2703E-05  0.0000E+00
     125 -4.7983E-05  6.9542E-06  6.0082E-06  0.0000E+00
     121  1.9250E-06  1.4031E-05 -4.5252E-05  0.0000E+00

 Slice at 3 index =  1

     157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     153  3.3546E-05 -1.7731E-05 -1.5181E-06  0.0000E+00
     149 -5.2458E-05  2.1568E-05  1.5998E-05  0.0000E+00
     145 -2.7856E-06  1.3141E-06 -1.5971E-05  0.0000E+00
     141 -1.3671E-05 -9.0376E-06  9.0478E-06  0.0000E+00

 Slice at 3 index =  2

     177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     173 -1.3066E-05  8.0653E-07 -2.2348E-05  0.0000E+00
     169 -1.1558E-06 -3.0195E-05  4.1923E-06  0.0000E+00
     165  8.4471E-07 -4.7575E-05  1.7854E-05  0.0000E+00
     161 -3.6155E-05  7.8622E-06 -2.4638E-05  0.0000E+00

 Slice at 3 index =  3

     197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     193 -5.3963E-06 -1.5456E-05  2.9932E-05  0.0000E+00
     189  2.1896E-05  3.1238E-05 -8.1440E-06  0.0000E+00
     185  1.8008E-05  1.0403E-05 -1.9901E-05  0.0000E+00
     181  1.9348E-05 -5.0608E-06 -2.3330E-06  0.0000E+00

 Slice at 3 index =  4

     217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     213  4.2403E-05  1.4103E-05 -3.8036E-05  0.0000E+00
     209 -1.7983E-05 -4.4494E-06  1.0098E-05  0.0000E+00
     205  1.8706E-05  3.0702E-05  3.0682E-05  0.0000E+00
     201  2.5306E-05 -1.9463E-05  4.3608E-05  0.0000E+00

 Slice at 3 index =  5

     237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     233  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     229  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     225  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     221  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component 3



 Slice at 3 index =  0

     257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     253  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
     249  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
     245  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
     241  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00

 Slice at 3 index =  1

     277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     273  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
     269  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
     265  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
     261  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00

 Slice at 3 index =  2

     297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     293  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
     289  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
     285  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
     281  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00

 Slice at 3 index =  3

     317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     313  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
     309  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
     305  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
     301  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00

 Slice at 3 index =  4

     337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
```

```
      333  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
      329  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
      325  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
      321  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00

 Slice at 3 index =  5

      357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      353  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
      349  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
      345  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
      341  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00



   BLOCK     =            4


d Component 1



 Slice at 3 index =  0

       17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       13 -2.5362E-02 -1.3445E-02  1.7575E-02  0.0000E+00
        9  7.3067E-03  2.8846E-03  5.4452E-04  0.0000E+00
        5  5.3170E-02  2.2368E-02  1.2752E-02  0.0000E+00
        1  2.3590E-02  2.3434E-02  9.1343E-03  0.0000E+00

 Slice at 3 index =  1

       37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       33 -2.5370E-02 -1.3401E-02  1.7602E-02  0.0000E+00
       29  7.3026E-03  2.8273E-03  5.3866E-04  0.0000E+00
       25  5.3141E-02  2.2348E-02  1.2760E-02  0.0000E+00
       21  2.3598E-02  2.3483E-02  9.1705E-03  0.0000E+00

 Slice at 3 index =  2

       57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       53 -2.5395E-02 -1.3413E-02  1.7616E-02  0.0000E+00
       49  7.3039E-03  2.8388E-03  5.2770E-04  0.0000E+00
       45  5.3191E-02  2.2389E-02  1.2820E-02  0.0000E+00
       41  2.3502E-02  2.3438E-02  9.1515E-03  0.0000E+00

 Slice at 3 index =  3

       77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       73 -2.5405E-02 -1.3468E-02  1.7611E-02  0.0000E+00
       69  7.3324E-03  2.8677E-03  5.2550E-04  0.0000E+00
       65  5.3196E-02  2.2398E-02  1.2724E-02  0.0000E+00
       61  2.3537E-02  2.3422E-02  9.1858E-03  0.0000E+00
```

```
 Slice at 3 index =  4

       97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       93 -2.5373E-02 -1.3399E-02  1.7602E-02  0.0000E+00
       89  7.3104E-03  2.8146E-03  5.5460E-04  0.0000E+00
       85  5.3158E-02  2.2373E-02  1.2736E-02  0.0000E+00
       81  2.3609E-02  2.3438E-02  9.1515E-03  0.0000E+00

 Slice at 3 index =  5

      117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      113 -2.5362E-02 -1.3423E-02  1.7593E-02  0.0000E+00
      109  7.3090E-03  2.8946E-03  5.6254E-04  0.0000E+00
      105  5.3183E-02  2.2381E-02  1.2745E-02  0.0000E+00
      101  2.3560E-02  2.3399E-02  9.1286E-03  0.0000E+00


d Component 2


 Slice at 3 index =  0

      137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      133  0.0000E+00  1.5116E-02  3.9558E-03  2.5877E-02
      129  0.0000E+00  2.7040E-02  3.4975E-02  7.6885E-03
      125  0.0000E+00  2.2617E-02  3.2639E-02 -8.3218E-03
      121  0.0000E+00 -8.2073E-03  2.3043E-02  8.4610E-03

 Slice at 3 index =  1

      157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      153  0.0000E+00  1.5114E-02  3.9482E-03  2.5860E-02
      149  0.0000E+00  2.7092E-02  3.4924E-02  7.6981E-03
      145  0.0000E+00  2.2598E-02  3.2661E-02 -8.3351E-03
      141  0.0000E+00 -8.1978E-03  2.3067E-02  8.4763E-03

 Slice at 3 index =  2

      177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      173  0.0000E+00  1.5064E-02  3.9482E-03  2.5879E-02
      169  0.0000E+00  2.7042E-02  3.4966E-02  7.5722E-03
      165  0.0000E+00  2.2617E-02  3.2631E-02 -8.3313E-03
      161  0.0000E+00 -8.1902E-03  2.3067E-02  8.4953E-03

 Slice at 3 index =  3

      197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      193  0.0000E+00  1.5125E-02  3.9215E-03  2.5829E-02
      189  0.0000E+00  2.7081E-02  3.5004E-02  7.5569E-03
      185  0.0000E+00  2.2583E-02  3.2658E-02 -8.3313E-03
      181  0.0000E+00 -8.2245E-03  2.3026E-02  8.4877E-03
 Slice at 3 index =   4

       217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       213  0.0000E+00  1.5121E-02  3.9635E-03  2.5818E-02
       209  0.0000E+00  2.7081E-02  3.4962E-02  7.6447E-03
       205  0.0000E+00  2.2606E-02  3.2711E-02 -8.3618E-03
       201  0.0000E+00 -8.1749E-03  2.3029E-02  8.4915E-03

 Slice at 3 index =   5

       237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       233  0.0000E+00  1.5099E-02  3.9806E-03  2.5862E-02
       229  0.0000E+00  2.7048E-02  3.4994E-02  7.6370E-03
       225  0.0000E+00  2.2633E-02  3.2656E-02 -8.3656E-03
       221  0.0000E+00 -8.1787E-03  2.3033E-02  8.4496E-03



d Component  3



 Slice at 3 index =   0

       257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       253  0.0000E+00  1.3792E-05  1.0358E-05 -7.5168E-06
       249  0.0000E+00  3.2963E-06  2.0335E-06 -1.7402E-06
       245  0.0000E+00 -1.8473E-06 -1.0157E-05  1.4431E-05
       241  0.0000E+00  1.0563E-05 -7.0331E-07 -9.3077E-06

 Slice at 3 index =   1

       277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       273  0.0000E+00  6.5079E-06 -1.0925E-05 -1.4240E-05
       269  0.0000E+00  9.0662E-07  4.1422E-06  1.4355E-05
       265  0.0000E+00 -1.0339E-05  6.4828E-06 -1.7464E-06
       261  0.0000E+00 -5.3998E-06  1.1984E-05 -1.2800E-05

 Slice at 3 index =   2

       297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       293  0.0000E+00 -7.8412E-06  9.2409E-07  4.1083E-06
       289  0.0000E+00  9.1052E-06 -8.9376E-06 -5.1041E-07
       285  0.0000E+00  2.9261E-06 -1.1685E-05  6.7813E-06
       281  0.0000E+00  1.1766E-05 -3.3839E-06  9.7668E-06

 Slice at 3 index =   3

       317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       313  0.0000E+00  6.3073E-06 -3.1710E-06  6.6768E-06
       309  0.0000E+00 -1.7723E-05 -1.9120E-07 -1.8278E-06
       305  0.0000E+00  1.3220E-05  3.9005E-06 -2.8450E-06
       301  0.0000E+00 -4.4357E-06 -1.2753E-05 -7.6398E-06

 Slice at 3 index =   4
```

```
       337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       333  0.0000E+00 -1.1893E-05 -3.1235E-06  6.6375E-06
       329  0.0000E+00  1.1803E-05  4.0189E-06 -1.3571E-05
       325  0.0000E+00 -1.0326E-06  4.4668E-06 -7.3097E-06
       321  0.0000E+00 -1.4462E-05 -7.5565E-06  2.1484E-05

 Slice at 3 index =   5

       357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       353  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       349  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       345  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       341  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



   BLOCK     =            4



b Component  1



 Slice at 3 index =   0

        17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        13  0.0000E+00  4.2896E-06  2.6734E-06 -7.1636E-06
         9  0.0000E+00  4.1303E-06  2.9102E-06  8.1667E-06
         5  0.0000E+00  1.2573E-06 -3.8966E-05  3.2181E-05
         1  0.0000E+00  7.7289E-06  7.7963E-06  1.0174E-05

 Slice at 3 index =   1

        37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        33  0.0000E+00 -7.1079E-06 -1.9443E-06 -5.3578E-06
        29  0.0000E+00 -1.3620E-05  2.7178E-06 -1.2215E-05
        25  0.0000E+00 -2.3087E-05  1.7237E-05 -2.6015E-05
        21  0.0000E+00 -8.7804E-06 -8.8052E-06 -1.8861E-06

 Slice at 3 index =   2

        57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        53  0.0000E+00 -2.0384E-06 -1.2379E-05 -1.1652E-05
        49  0.0000E+00  6.4207E-06  4.5587E-07  1.7279E-05
        45  0.0000E+00  1.3839E-05 -6.4388E-06  2.1840E-05
        41  0.0000E+00  1.1716E-06  4.7219E-06  2.0757E-05

 Slice at 3 index =   3

        77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        73  0.0000E+00 -1.5556E-05  2.6511E-05  1.0508E-05
        69  0.0000E+00 -6.9970E-06  3.5178E-05 -6.6537E-06
```

```
     65  0.0000E+00  6.3414E-06  3.4153E-05 -1.8759E-05
     61  0.0000E+00  1.1430E-05  6.4237E-06 -1.5630E-05

 Slice at 3 index =  4

     97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     93  0.0000E+00  1.3343E-05  6.0355E-06 -1.3587E-05
     89  0.0000E+00  3.5033E-05 -2.2524E-05 -9.6091E-06
     85  0.0000E+00  1.2987E-05  1.0047E-05 -7.0047E-06
     81  0.0000E+00  7.5088E-06  3.7614E-06 -1.8973E-05

 Slice at 3 index =  5

    117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    113  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    109  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    105  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component  2



 Slice at 3 index =  0

    137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    133 -1.5807E-05  2.9993E-06  3.2773E-06  0.0000E+00
    129 -1.4307E-05  5.8457E-06  2.9039E-05  0.0000E+00
    125  8.1994E-06  2.5132E-05 -2.7975E-05  0.0000E+00
    121  2.8840E-05 -4.5560E-05 -2.9227E-05  0.0000E+00

 Slice at 3 index =  1

    157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    153  1.3128E-05 -2.8145E-05  1.0746E-05  0.0000E+00
    149  3.7507E-06  2.0969E-05 -6.1304E-07  0.0000E+00
    145  6.5770E-06 -3.3092E-05  2.8848E-05  0.0000E+00
    141  6.2694E-05  2.6226E-06 -1.1902E-05  0.0000E+00

 Slice at 3 index =  2

    177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    173  2.0718E-05  8.9713E-05 -8.0168E-06  0.0000E+00
    169 -3.1555E-05 -5.3512E-05 -7.2868E-06  0.0000E+00
    165 -1.5220E-05 -3.4375E-06  2.5011E-06  0.0000E+00
    161  4.6110E-06  4.2945E-05 -3.8808E-06  0.0000E+00

 Slice at 3 index =  3

    197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    193  3.6105E-05 -5.3698E-05  2.7437E-06  0.0000E+00
    189  1.4995E-05 -2.0412E-06 -3.8159E-05  0.0000E+00
    185  5.7556E-07 -1.1167E-05  1.3808E-05  0.0000E+00
```

```
    181 -5.2063E-05  6.2026E-06  2.5633E-05  0.0000E+00

 Slice at 3 index =  4

    217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    213  2.1730E-05  2.3141E-05  3.5865E-05  0.0000E+00
    209 -2.4926E-05 -1.3008E-05 -3.2961E-05  0.0000E+00
    205  1.7881E-05  2.5716E-05  1.2601E-05  0.0000E+00
    201 -5.5148E-05 -3.0408E-05  3.1360E-05  0.0000E+00

 Slice at 3 index =  5

    237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    233  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    229  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    225  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    221  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component  3



 Slice at 3 index =  0

    257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    253  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
    249  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
    245  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
    241  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00

 Slice at 3 index =  1

    277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    273  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
    269  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
    265  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
    261  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00

 Slice at 3 index =  2

    297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    293  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
    289  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
    285  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
    281  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00

 Slice at 3 index =  3

    317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    313  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
    309  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
    305  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
    301  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00
 Slice at 3 index =  4

       337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       333  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
       329  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
       325  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
       321  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00

 Slice at 3 index =  5

       357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       353  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
       349  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
       345  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
       341  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00



   BLOCK     =            5



d Component  1



 Slice at 3 index =  0

        17  2.3560E-02  2.3399E-02  9.1286E-03  0.0000E+00
        13  1.6093E-02  1.1704E-02  5.8003E-03  0.0000E+00
         9  2.5238E-02  1.2861E-02 -9.5337E-03  0.0000E+00
         5 -2.2983E-02 -7.2239E-03 -2.3685E-02  0.0000E+00
         1  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  1

        37  2.3632E-02  2.3491E-02  9.0828E-03  0.0000E+00
        33  1.6059E-02  1.1670E-02  5.8161E-03  0.0000E+00
        29  2.5198E-02  1.2955E-02 -9.5078E-03  0.0000E+00
        25 -2.2958E-02 -7.3148E-03 -2.3705E-02  0.0000E+00
        21  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  2

        57  2.3609E-02  2.3464E-02  9.0866E-03  0.0000E+00
        53  1.6055E-02  1.1684E-02  5.7592E-03  0.0000E+00
        49  2.5257E-02  1.2870E-02 -9.5478E-03  0.0000E+00
        45 -2.3058E-02 -7.2557E-03 -2.3662E-02  0.0000E+00
        41  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  3

        77  2.3640E-02  2.3483E-02  9.1324E-03  0.0000E+00
        73  1.6030E-02  1.1655E-02  5.7623E-03  0.0000E+00
        69  2.5243E-02  1.2852E-02 -9.4713E-03  0.0000E+00
        65 -2.2990E-02 -7.2681E-03 -2.3671E-02  0.0000E+00
        61  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  4

        97  2.3632E-02  2.3472E-02  9.0981E-03  0.0000E+00
        93  1.6037E-02  1.1702E-02  5.8119E-03  0.0000E+00
        89  2.5238E-02  1.2837E-02 -9.5141E-03  0.0000E+00
        85 -2.2943E-02 -7.2443E-03 -2.3697E-02  0.0000E+00
        81  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  5

       117  2.3590E-02  2.3434E-02  9.1343E-03  0.0000E+00
       113  1.6075E-02  1.1697E-02  5.8073E-03  0.0000E+00
       109  2.5260E-02  1.2852E-02 -9.5317E-03  0.0000E+00
       105 -2.3010E-02 -7.1974E-03 -2.3700E-02  0.0000E+00
       101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



d Component  2



 Slice at 3 index =  0

       137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       133  0.0000E+00 -8.3389E-03  8.7566E-03 -7.8621E-03
       129  0.0000E+00 -1.2728E-02  2.8400E-03  3.8624E-03
       125  0.0000E+00 -2.5105E-02 -1.9556E-02 -1.7708E-02
       121  0.0000E+00 -9.3670E-03 -3.5997E-02 -3.7989E-02

 Slice at 3 index =  1

       157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       153  0.0000E+00 -8.3466E-03  8.6823E-03 -7.8545E-03
       149  0.0000E+00 -1.2749E-02  2.8458E-03  3.9139E-03
       145  0.0000E+00 -2.4998E-02 -1.9604E-02 -1.7784E-02
       141  0.0000E+00 -9.3307E-03 -3.6011E-02 -3.8002E-02

 Slice at 3 index =  2

       177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       173  0.0000E+00 -8.3580E-03  8.7814E-03 -7.9193E-03
       169  0.0000E+00 -1.2741E-02  2.8419E-03  3.9101E-03
       165  0.0000E+00 -2.5135E-02 -1.9547E-02 -1.7750E-02
       161  0.0000E+00 -9.3269E-03 -3.5957E-02 -3.8040E-02

 Slice at 3 index =  3

       197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       193  0.0000E+00 -8.3580E-03  8.7204E-03 -7.9536E-03
```

```
      189  0.0000E+00 -1.2722E-02  2.8038E-03  3.8948E-03
      185  0.0000E+00 -2.5089E-02 -1.9512E-02 -1.7780E-02
      181  0.0000E+00 -9.3918E-03 -3.5931E-02 -3.8078E-02

 Slice at 3 index =  4

      217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      213  0.0000E+00 -8.3199E-03  8.6899E-03 -7.8812E-03
      209  0.0000E+00 -1.2661E-02  2.8267E-03  3.8834E-03
      205  0.0000E+00 -2.5085E-02 -1.9550E-02 -1.7780E-02
      201  0.0000E+00 -9.3117E-03 -3.6018E-02 -3.7998E-02

 Slice at 3 index =  5

      237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      233  0.0000E+00 -8.3485E-03  8.7433E-03 -7.9002E-03
      229  0.0000E+00 -1.2735E-02  2.8210E-03  3.8643E-03
      225  0.0000E+00 -2.5127E-02 -1.9562E-02 -1.7756E-02
      221  0.0000E+00 -9.3250E-03 -3.6057E-02 -3.8002E-02



d Component 3



 Slice at 3 index =  0

      257  0.0000E+00 -1.4447E-06  4.5056E-06  1.5859E-06
      253  0.0000E+00  2.0072E-05 -4.9998E-07  3.1468E-07
      249  0.0000E+00 -4.8403E-06 -2.8580E-06 -7.2656E-06
      245  0.0000E+00 -6.6773E-06  5.4836E-06  2.4554E-06
      241  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  1

      277  0.0000E+00 -1.4526E-05  9.3750E-06  4.0280E-06
      273  0.0000E+00  3.6585E-06  8.5635E-06  3.3244E-06
      269  0.0000E+00 -6.2745E-06 -4.6881E-06  8.7223E-06
      265  0.0000E+00  9.2329E-06 -6.6588E-06 -7.1600E-07
      261  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  2

      297  0.0000E+00  1.4288E-05 -1.4763E-05 -5.3102E-06
      293  0.0000E+00  5.8764E-07 -3.9147E-06 -1.4891E-06
      289  0.0000E+00  3.5953E-06 -1.6441E-06 -5.5517E-06
      285  0.0000E+00 -7.8827E-06  1.0001E-06 -1.0139E-06
      281  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  3

      317  0.0000E+00 -4.9884E-06  5.9328E-06  1.0668E-06
      313  0.0000E+00 -2.4399E-06 -1.1299E-05 -5.1941E-07
      309  0.0000E+00  4.1983E-07  7.6244E-06  7.5613E-06
```

```
      305  0.0000E+00 -3.1112E-06 -1.1455E-06  3.1404E-06
      301  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  4

      337  0.0000E+00  8.6446E-06  7.3648E-06 -2.8715E-06
      333  0.0000E+00 -1.8021E-05  2.3537E-07 -1.5590E-06
      329  0.0000E+00 -3.3705E-06 -7.8898E-07  9.0436E-06
      325  0.0000E+00  9.0465E-06  2.1459E-06  1.0611E-06
      321  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  5

      357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      353  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      349  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      345  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      341  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



    BLOCK     =             5



b Component 1



 Slice at 3 index =  0

       17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       13  0.0000E+00  9.3660E-06 -1.4181E-05 -2.1015E-05
        9  0.0000E+00  3.1421E-06 -9.6492E-06  2.8280E-05
        5  0.0000E+00  7.5284E-06 -2.0562E-05 -3.0218E-05
        1  0.0000E+00  1.1548E-05  1.4217E-05 -1.2230E-05

 Slice at 3 index =  1

       37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       33  0.0000E+00 -6.3386E-06  1.3717E-05  5.8026E-06
       29  0.0000E+00 -2.8743E-05 -9.5186E-06 -1.9630E-05
       25  0.0000E+00 -2.1711E-07  2.6199E-05  3.2288E-06
       21  0.0000E+00  1.1961E-05  2.8704E-05 -2.8647E-05

 Slice at 3 index =  2

       57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       53  0.0000E+00  1.4164E-05 -1.6199E-05 -1.2600E-05
       49  0.0000E+00  3.0852E-05  2.1489E-06 -7.6521E-06
       45  0.0000E+00  8.8823E-06 -3.0160E-05  3.8401E-06
       41  0.0000E+00 -1.6194E-05 -1.7203E-05  6.7458E-06

 Slice at 3 index =  3
```

```
      77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      73  0.0000E+00 -2.2007E-05 -1.4634E-09  1.9875E-05
      69  0.0000E+00 -9.7034E-06  2.3179E-05  3.2706E-05
      65  0.0000E+00 -2.2533E-05  2.9567E-05  8.9056E-06
      61  0.0000E+00  2.7246E-05 -9.6565E-06  1.7635E-05

 Slice at 3 index =  4

      97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      93  0.0000E+00 -2.5090E-05  1.5436E-05  2.6855E-07
      89  0.0000E+00 -3.5649E-05 -2.7960E-05 -2.7835E-06
      85  0.0000E+00 -1.5737E-05 -1.8078E-05  1.0449E-05
      81  0.0000E+00 -5.8550E-05 -3.7604E-05  1.3568E-05

 Slice at 3 index =  5

     117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     113  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     109  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     105  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component 2



 Slice at 3 index =  0

     137 -2.9271E-06 -1.5764E-05 -9.8171E-06  0.0000E+00
     133 -5.4436E-07  9.8310E-06  3.8207E-05  0.0000E+00
     129  3.7880E-05 -1.6768E-05 -2.2568E-05  0.0000E+00
     125 -4.1164E-07  4.6072E-05  1.7750E-05  0.0000E+00
     121  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  1

     157 -1.2280E-05  2.2628E-05  2.8815E-06  0.0000E+00
     153 -4.7171E-07 -1.0955E-05  6.9130E-06  0.0000E+00
     149 -1.8729E-06  2.1591E-05  2.7907E-06  0.0000E+00
     145  3.1798E-05 -3.0702E-05 -4.7149E-05  0.0000E+00
     141  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  2

     177  4.4027E-05 -2.0227E-05 -2.1074E-05  0.0000E+00
     173 -9.1456E-06  2.3915E-05  9.4734E-06  0.0000E+00
     169 -2.8973E-05 -2.1575E-05  1.6578E-07  0.0000E+00
     165 -3.6404E-05  1.3822E-05 -4.8894E-06  0.0000E+00
     161  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  3
```

```
     197 -4.1370E-05  2.6091E-05  1.2620E-05  0.0000E+00
     193  2.7595E-06 -4.0100E-05 -3.3333E-05  0.0000E+00
     189  9.0068E-06  2.7115E-05  1.1460E-06  0.0000E+00
     185  1.5408E-05 -1.5639E-05  3.8141E-05  0.0000E+00
     181  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  4

     217  2.3620E-05  1.1479E-05  3.4049E-06  0.0000E+00
     213  4.4840E-05  3.5114E-05  1.2524E-05  0.0000E+00
     209 -4.3736E-05 -1.0436E-05  2.2503E-05  0.0000E+00
     205  1.4711E-05 -9.7260E-06 -1.2178E-05  0.0000E+00
     201  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  5

     237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     233  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     229  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     225  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     221  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component 3



 Slice at 3 index =  0

     257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     253  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
     249  8.0146E+01  8.4733E+01  8.9319E+01  0.0000E+00
     245  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
     241  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00

 Slice at 3 index =  1

     277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     273  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
     269  8.0146E+01  8.4733E+01  8.9319E+01  0.0000E+00
     265  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
     261  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00

 Slice at 3 index =  2

     297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     293  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
     289  8.0146E+01  8.4733E+01  8.9319E+01  0.0000E+00
     285  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
     281  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00

 Slice at 3 index =  3

     317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     313  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
     309  8.0146E+01  8.4733E+01  8.9319E+01  0.0000E+00
     305  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
     301  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00

 Slice at 3 index =  4

     337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     333  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
     329  8.0146E+01  8.4733E+01  8.9319E+01  0.0000E+00
     325  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
     321  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00

 Slice at 3 index =  5

     357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     353  8.9323E+01  9.3910E+01  9.8513E+01  0.0000E+00
     349  8.0146E+01  8.4733E+01  8.9319E+01  0.0000E+00
     345  7.0985E+01  7.5567E+01  8.0158E+01  0.0000E+00
     341  6.1801E+01  6.6361E+01  7.0965E+01  0.0000E+00



   BLOCK     =            6


d Component 1



 Slice at 3 index =  0

      17 -7.1964E-03 -4.1142E-02 -3.8887E-02  0.0000E+00
      13  1.7543E-02 -1.5319E-02 -9.5449E-02  0.0000E+00
       9 -3.1131E-02 -1.0194E-02  1.7317E-02  0.0000E+00
       5 -4.3964E-02  1.8918E-02  4.2696E-02  0.0000E+00
       1  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  1

      37 -7.2289E-03 -4.1096E-02 -3.8857E-02  0.0000E+00
      33  1.7578E-02 -1.5339E-02 -9.5486E-02  0.0000E+00
      29 -3.1211E-02 -1.0155E-02  1.7339E-02  0.0000E+00
      25 -4.3945E-02  1.8924E-02  4.2723E-02  0.0000E+00
      21  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  2

      57 -7.1945E-03 -4.1077E-02 -3.8891E-02  0.0000E+00
      53  1.7596E-02 -1.5390E-02 -9.5465E-02  0.0000E+00
      49 -3.1143E-02 -1.0157E-02  1.7322E-02  0.0000E+00
      45 -4.3974E-02  1.8907E-02  4.2715E-02  0.0000E+00
      41  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
```

```
 Slice at 3 index =  3

      77 -7.2441E-03 -4.1115E-02 -3.8849E-02  0.0000E+00
      73  1.7617E-02 -1.5340E-02 -9.5422E-02  0.0000E+00
      69 -3.1180E-02 -1.0190E-02  1.7307E-02  0.0000E+00
      65 -4.3956E-02  1.8950E-02  4.2697E-02  0.0000E+00
      61  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  4

      97 -7.2098E-03 -4.1115E-02 -3.8887E-02  0.0000E+00
      93  1.7584E-02 -1.5330E-02 -9.5457E-02  0.0000E+00
      89 -3.1166E-02 -1.0206E-02  1.7322E-02  0.0000E+00
      85 -4.3934E-02  1.8980E-02  4.2697E-02  0.0000E+00
      81  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  5

     117 -7.2403E-03 -4.1113E-02 -3.8870E-02  0.0000E+00
     113  1.7580E-02 -1.5354E-02 -9.5509E-02  0.0000E+00
     109 -3.1164E-02 -1.0221E-02  1.7341E-02  0.0000E+00
     105 -4.3956E-02  1.8974E-02  4.2700E-02  0.0000E+00
     101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



d Component 2



 Slice at 3 index =  0

     137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     133 -7.8621E-03 -2.2261E-02  2.2131E-02  0.0000E+00
     129  3.8624E-03 -5.5130E-02 -5.8001E-02  0.0000E+00
     125 -1.7708E-02 -3.4166E-02 -3.0506E-02  0.0000E+00
     121 -3.7989E-02  2.8702E-02 -6.7368E-03  0.0000E+00

 Slice at 3 index =  1

     157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     153 -7.8545E-03 -2.2243E-02  2.2110E-02  0.0000E+00
     149  3.9139E-03 -5.5145E-02 -5.8025E-02  0.0000E+00
     145 -1.7784E-02 -3.4149E-02 -3.0537E-02  0.0000E+00
     141 -3.8002E-02  2.8725E-02 -6.7291E-03  0.0000E+00

 Slice at 3 index =  2

     177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     173 -7.9193E-03 -2.2190E-02  2.2095E-02  0.0000E+00
     169  3.9101E-03 -5.5187E-02 -5.7991E-02  0.0000E+00
     165 -1.7750E-02 -3.4184E-02 -3.0506E-02  0.0000E+00
     161 -3.8040E-02  2.8694E-02 -6.6910E-03  0.0000E+00
 Slice at 3 index =  3

      197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      193 -7.9536E-03 -2.2186E-02  2.2076E-02  0.0000E+00
      189  3.8948E-03 -5.5111E-02 -5.8002E-02  0.0000E+00
      185 -1.7780E-02 -3.4142E-02 -3.0506E-02  0.0000E+00
      181 -3.8078E-02  2.8759E-02 -6.7596E-03  0.0000E+00

 Slice at 3 index =  4

      217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      213 -7.8812E-03 -2.2209E-02  2.2106E-02  0.0000E+00
      209  3.8834E-03 -5.5149E-02 -5.8052E-02  0.0000E+00
      205 -1.7780E-02 -3.4161E-02 -3.0510E-02  0.0000E+00
      201 -3.7998E-02  2.8759E-02 -6.7978E-03  0.0000E+00

 Slice at 3 index =  5

      237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      233 -7.9002E-03 -2.2203E-02  2.2120E-02  0.0000E+00
      229  3.8643E-03 -5.5140E-02 -5.8020E-02  0.0000E+00
      225 -1.7756E-02 -3.4178E-02 -3.0493E-02  0.0000E+00
      221 -3.8002E-02  2.8740E-02 -6.7482E-03  0.0000E+00



d Component 3



 Slice at 3 index =  0

      257  1.5859E-06  1.3791E-05 -1.0895E-05  0.0000E+00
      253  3.1468E-07 -1.5385E-05  1.9539E-05  0.0000E+00
      249 -7.2656E-06  1.4945E-05 -4.4404E-06  0.0000E+00
      245  2.4554E-06  3.5115E-06 -4.2342E-06  0.0000E+00
      241  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  1

      277  4.0280E-06 -7.4766E-06  7.4841E-06  0.0000E+00
      273  3.3244E-06 -4.2481E-06  7.8820E-07  0.0000E+00
      269  8.7223E-06 -4.5728E-06  1.4633E-06  0.0000E+00
      265 -7.1600E-07 -1.4520E-05  2.2875E-05  0.0000E+00
      261  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  2

      297 -5.3102E-06 -3.1303E-06 -4.4466E-06  0.0000E+00
      293 -1.4891E-06  4.3415E-06 -2.4581E-06  0.0000E+00
      289 -5.5517E-06 -2.9988E-06  7.9825E-06  0.0000E+00
      285 -1.0139E-06  7.3470E-06 -9.3092E-06  0.0000E+00
      281  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  3
```

```
      317  1.0668E-06  6.7646E-06  2.9581E-06  0.0000E+00
      313 -5.1941E-07  1.0475E-05  1.6310E-06  0.0000E+00
      309  7.5613E-06 -1.9995E-06  3.8625E-06  0.0000E+00
      305  3.1404E-06 -1.6127E-06 -1.1152E-06  0.0000E+00
      301  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  4

      337 -2.8715E-06 -1.9971E-06  2.3381E-06  0.0000E+00
      333 -1.5590E-06  7.8818E-06 -4.0725E-06  0.0000E+00
      329  9.0436E-06 -5.9063E-07  2.0056E-08  0.0000E+00
      325  1.0611E-06  1.6784E-06 -1.1752E-05  0.0000E+00
      321  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  5

      357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      353  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      349  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      345  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      341  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



   BLOCK     =            6



b Component 1



 Slice at 3 index =  0

       17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       13 -2.1017E-05  2.9518E-06  1.0991E-05  0.0000E+00
        9  2.8282E-05 -1.6048E-05  3.4890E-06  0.0000E+00
        5 -3.0221E-05  1.5115E-05  5.0726E-06  0.0000E+00
        1 -1.2232E-05 -4.5694E-06  3.4195E-05  0.0000E+00

 Slice at 3 index =  1

       37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       33  5.8026E-06 -1.9366E-07  2.6258E-06  0.0000E+00
       29 -1.9630E-05  2.8229E-05 -8.8927E-06  0.0000E+00
       25  3.2288E-06  1.5342E-05 -2.2290E-05  0.0000E+00
       21 -2.8647E-05  1.2529E-05 -1.7003E-05  0.0000E+00

 Slice at 3 index =  2

       57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       53 -1.2600E-05  1.4912E-05 -7.5446E-06  0.0000E+00
       49 -7.6521E-06  1.1339E-05 -1.0546E-05  0.0000E+00
```

```
        45  3.8401E-06  9.9209E-06  1.0197E-05  0.0000E+00
        41  6.7458E-06 -6.9273E-06  1.4270E-05  0.0000E+00

 Slice at 3 index =  3

        77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        73  1.9875E-05  2.4792E-05 -3.6333E-05  0.0000E+00
        69  3.2706E-05 -3.2316E-05  5.3705E-06  0.0000E+00
        65  8.9056E-06 -1.6119E-05 -7.1147E-06  0.0000E+00
        61  1.7635E-05  2.2324E-06  1.1975E-05  0.0000E+00

 Slice at 3 index =  4

        97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        93  2.6901E-07 -3.8076E-05  4.2178E-05  0.0000E+00
        89 -2.7816E-06  2.5429E-05 -1.4922E-05  0.0000E+00
        85  1.0449E-05  5.1224E-06  1.6238E-05  0.0000E+00
        81  1.3566E-05  1.6511E-05 -1.7360E-05  0.0000E+00

 Slice at 3 index =  5

       117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       113  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       109  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       105  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component  2



 Slice at 3 index =  0

       137  2.1317E-05  1.2007E-05 -1.4715E-06  0.0000E+00
       133 -7.4224E-05 -4.0941E-06 -1.2990E-05  0.0000E+00
       129  1.3542E-04 -2.0971E-05  7.0222E-07  0.0000E+00
       125 -1.3988E-05  3.5064E-05 -5.6811E-07  0.0000E+00
       121  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  1

       157  8.3589E-06 -7.6741E-06 -1.4497E-05  0.0000E+00
       153  2.0023E-05  1.9203E-05  3.6798E-05  0.0000E+00
       149 -6.3771E-05  1.0924E-06  1.2022E-05  0.0000E+00
       145  4.1759E-05  1.1369E-05 -1.6790E-05  0.0000E+00
       141  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  2

       177 -1.4902E-05  3.3844E-06 -1.7846E-05  0.0000E+00
       173  8.2422E-06 -1.9189E-05  2.3782E-05  0.0000E+00
       169 -3.3770E-06  2.0788E-05 -5.5020E-05  0.0000E+00
       165 -4.3696E-05 -3.4921E-05  3.4600E-05  0.0000E+00
```

```
       161  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  3

       197  2.3751E-06 -2.0161E-05  2.6955E-05  0.0000E+00
       193 -3.2239E-05  5.1972E-05 -4.5441E-05  0.0000E+00
       189  7.5772E-06 -4.5029E-05  2.3210E-05  0.0000E+00
       185  2.8484E-05  3.1563E-06 -5.1565E-05  0.0000E+00
       181  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  4

       217 -1.3901E-05  2.4103E-05  2.6424E-05  0.0000E+00
       213  2.2367E-05 -7.2470E-05  1.1202E-05  0.0000E+00
       209 -1.7414E-05  7.5435E-05 -2.3803E-05  0.0000E+00
       205 -2.8213E-05 -2.9001E-05  2.3676E-05  0.0000E+00
       201  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

 Slice at 3 index =  5

       237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       233  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       229  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       225  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       221  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component  3



 Slice at 3 index =  0

       257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       253  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
       249  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
       245  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
       241  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00

 Slice at 3 index =  1

       277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       273  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
       269  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
       265  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
       261  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00

 Slice at 3 index =  2

       297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       293  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
       289  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
       285  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
       281  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00
 Slice at 3 index =  3

       317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       313  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
       309  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
       305  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
       301  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00

 Slice at 3 index =  4

       337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       333  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
       329  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
       325  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
       321  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00

 Slice at 3 index =  5

       357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       353  1.1748E+02  1.2821E+02  1.3892E+02  0.0000E+00
       349  1.3125E+02  1.4196E+02  1.5263E+02  0.0000E+00
       345  1.4502E+02  1.5573E+02  1.6637E+02  0.0000E+00
       341  1.5882E+02  1.6949E+02  1.8013E+02  0.0000E+00



   BLOCK     =            7



d Component 1



 Slice at 3 index =  0

        17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        13 -6.3543E-04  2.5216E-02  4.7881E-02  0.0000E+00
         9 -1.5457E-02 -2.4711E-02  1.3813E-02  0.0000E+00
         5  2.9572E-02  2.0161E-02 -8.0792E-03  0.0000E+00
         1 -7.1964E-03 -4.1142E-02 -3.8887E-02  0.0000E+00

 Slice at 3 index =  1

        37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        33 -5.3589E-04  2.5103E-02  4.7890E-02  0.0000E+00
        29 -1.5511E-02 -2.4650E-02  1.3785E-02  0.0000E+00
        25  2.9600E-02  2.0133E-02 -8.0469E-03  0.0000E+00
        21 -7.2289E-03 -4.1096E-02 -3.8857E-02  0.0000E+00

 Slice at 3 index =  2

        57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        53 -5.7393E-04  2.5082E-02  4.7844E-02  0.0000E+00
        49 -1.5473E-02 -2.4659E-02  1.3786E-02  0.0000E+00
        45  2.9521E-02  2.0148E-02 -8.0743E-03  0.0000E+00
        41 -7.1945E-03 -4.1077E-02 -3.8891E-02  0.0000E+00

 Slice at 3 index =  3

        77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        73 -5.8732E-04  2.5145E-02  4.7877E-02  0.0000E+00
        69 -1.5415E-02 -2.4655E-02  1.3764E-02  0.0000E+00
        65  2.9514E-02  2.0147E-02 -8.1186E-03  0.0000E+00
        61 -7.2441E-03 -4.1115E-02 -3.8849E-02  0.0000E+00

 Slice at 3 index =  4

        97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        93 -5.6916E-04  2.5116E-02  4.7888E-02  0.0000E+00
        89 -1.5491E-02 -2.4657E-02  1.3778E-02  0.0000E+00
        85  2.9595E-02  2.0179E-02 -8.0637E-03  0.0000E+00
        81 -7.2098E-03 -4.1115E-02 -3.8887E-02  0.0000E+00

 Slice at 3 index =  5

       117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       113 -6.2618E-04  2.5171E-02  4.7899E-02  0.0000E+00
       109 -1.5464E-02 -2.4732E-02  1.3765E-02  0.0000E+00
       105  2.9552E-02  2.0175E-02 -8.0556E-03  0.0000E+00
       101 -7.2403E-03 -4.1113E-02 -3.8870E-02  0.0000E+00



d Component 2



 Slice at 3 index =  0

       137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       133  2.5862E-02  4.5204E-03 -1.3094E-02  0.0000E+00
       129  7.6370E-03  3.0342E-02  9.6092E-03  0.0000E+00
       125 -8.3656E-03  2.1097E-02  4.8115E-02  0.0000E+00
       121  8.4496E-03  1.1667E-02  1.9876E-02  0.0000E+00

 Slice at 3 index =  1

       157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       153  2.5841E-02  4.5853E-03 -1.3111E-02  0.0000E+00
       149  7.6942E-03  3.0254E-02  9.6474E-03  0.0000E+00
       145 -8.3656E-03  2.1088E-02  4.8077E-02  0.0000E+00
       141  8.4419E-03  1.1662E-02  1.9901E-02  0.0000E+00

 Slice at 3 index =  2

       177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       173  2.5860E-02  4.6043E-03 -1.3096E-02  0.0000E+00
       169  7.6714E-03  3.0258E-02  9.6359E-03  0.0000E+00
       165 -8.3466E-03  2.1107E-02  4.8088E-02  0.0000E+00
       161  8.3466E-03  1.1692E-02  1.9867E-02  0.0000E+00

 Slice at 3 index =  3

       197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       193  2.5841E-02  4.5624E-03 -1.3088E-02  0.0000E+00
       189  7.5874E-03  3.0323E-02  9.6588E-03  0.0000E+00
       185 -8.3466E-03  2.1099E-02  4.8069E-02  0.0000E+00
       181  8.3542E-03  1.1711E-02  1.9836E-02  0.0000E+00

 Slice at 3 index =  4

       217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       213  2.5795E-02  4.5853E-03 -1.3084E-02  0.0000E+00
       209  7.6485E-03  3.0281E-02  9.6664E-03  0.0000E+00
       205 -8.3542E-03  2.1088E-02  4.8100E-02  0.0000E+00
       201  8.4419E-03  1.1688E-02  1.9829E-02  0.0000E+00

 Slice at 3 index =  5

       237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       233  2.5877E-02  4.5319E-03 -1.3128E-02  0.0000E+00
       229  7.6885E-03  3.0287E-02  9.6226E-03  0.0000E+00
       225 -8.3218E-03  2.1040E-02  4.8126E-02  0.0000E+00
       221  8.4610E-03  1.1646E-02  1.9890E-02  0.0000E+00



d Component 3



 Slice at 3 index =  0

       257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       253  1.6843E-05 -3.6588E-05  2.8673E-05  0.0000E+00
       249 -1.6311E-05  1.1704E-05 -5.6287E-06  0.0000E+00
       245 -9.1576E-07 -1.2586E-05  8.1968E-06  0.0000E+00
       241  1.5859E-06  1.3791E-05 -1.0895E-05  0.0000E+00

 Slice at 3 index =  1

       277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       273 -1.4556E-05  9.6280E-06 -2.4057E-05  0.0000E+00
       269 -1.0890E-05  2.2940E-06  6.1993E-07  0.0000E+00
       265 -2.1590E-06  2.0041E-05  1.9642E-06  0.0000E+00
       261  4.0280E-06 -7.4766E-06  7.4841E-06  0.0000E+00

 Slice at 3 index =  2

       297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       293  8.4508E-06  7.0759E-07  4.2257E-07  0.0000E+00
       289  2.2464E-05 -1.2981E-05  1.5217E-06  0.0000E+00
```

```
       285  2.1100E-06 -6.6493E-06 -8.5267E-06  0.0000E+00
       281 -5.3102E-06 -3.1303E-06 -4.4466E-06  0.0000E+00

 Slice at 3 index =  3

       317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       313  6.8460E-07  5.4919E-06  7.4738E-06  0.0000E+00
       309 -5.8555E-06  9.5875E-06 -3.9115E-06  0.0000E+00
       305 -2.5823E-06 -3.7677E-06  6.7082E-06  0.0000E+00
       301  1.0668E-06  6.7646E-06  2.9581E-06  0.0000E+00

 Slice at 3 index =  4

       337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       333 -7.0883E-06  1.3904E-05 -1.0769E-05  0.0000E+00
       329  1.3885E-05 -1.8900E-05 -3.4394E-07  0.0000E+00
       325 -5.7639E-06  1.1867E-05 -5.3173E-07  0.0000E+00
       321 -2.8715E-06 -1.9971E-06  2.3381E-06  0.0000E+00

 Slice at 3 index =  5

       357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       353  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       349  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       345  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       341  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



   BLOCK     =              7



b Component 1



 Slice at 3 index =  0

        17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        13  2.9209E-05  4.8488E-06  4.3452E-05  0.0000E+00
         9  1.7935E-05  2.0948E-05 -4.5570E-06  0.0000E+00
         5 -3.0983E-06  1.8856E-06  2.9932E-06  0.0000E+00
         1 -1.8324E-05  1.0951E-05 -7.8385E-06  0.0000E+00

 Slice at 3 index =  1

        37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
        33  1.8218E-05  2.9993E-05 -7.5527E-06  0.0000E+00
        29 -1.2548E-05  1.1934E-05  1.8918E-05  0.0000E+00
        25 -4.5087E-06 -7.4875E-06  6.8085E-06  0.0000E+00
        21  3.0823E-05 -1.4597E-05 -2.4632E-06  0.0000E+00

 Slice at 3 index =  2
```

```
       57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       53 -1.1735E-05 -2.6266E-05 -1.3474E-05  0.0000E+00
       49 -2.8962E-05 -3.5948E-06 -3.3950E-06  0.0000E+00
       45  2.6334E-07  1.8893E-05  6.0494E-06  0.0000E+00
       41 -7.1957E-06  1.7519E-05  1.7723E-05  0.0000E+00

 Slice at 3 index =   3

       77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       73 -1.3927E-05  1.5317E-05 -6.0745E-06  0.0000E+00
       69  3.2856E-05 -3.1404E-05  2.6690E-06  0.0000E+00
       65  1.6520E-05 -6.0852E-06 -1.5056E-05  0.0000E+00
       61  1.0426E-05 -6.6349E-06 -1.5741E-05  0.0000E+00

 Slice at 3 index =   4

       97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       93  5.4885E-06 -8.3733E-06 -3.1517E-05  0.0000E+00
       89 -6.2482E-06 -1.0012E-05 -1.4021E-05  0.0000E+00
       85 -1.1415E-05  6.0535E-06 -8.4896E-06  0.0000E+00
       81 -1.0172E-05 -2.7737E-06  1.0313E-05  0.0000E+00

 Slice at 3 index =   5

      117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      113  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      109  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      105  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component 2



 Slice at 3 index =   0

      137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      133 -6.0364E-05  3.5583E-05 -1.1413E-05  0.0000E+00
      129  2.0710E-05 -2.5333E-05  2.8892E-05  0.0000E+00
      125 -4.8429E-07  1.1387E-05  3.2413E-05  0.0000E+00
      121  2.1311E-05  1.2008E-05 -1.4724E-06  0.0000E+00

 Slice at 3 index =   1

      157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      153  1.0570E-05  1.0959E-05  3.3616E-05  0.0000E+00
      149 -2.2321E-05  9.6606E-06  3.0016E-05  0.0000E+00
      145  1.4746E-05 -4.6613E-06 -4.7987E-05  0.0000E+00
      141  8.3591E-06 -7.6741E-06 -1.4497E-05  0.0000E+00

 Slice at 3 index =   2
```

```
      177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      173  3.6024E-05 -3.0864E-06 -5.6773E-06  0.0000E+00
      169 -1.2957E-05 -8.4201E-06 -3.0244E-05  0.0000E+00
      165 -2.5502E-05 -1.5062E-05  2.3096E-05  0.0000E+00
      161 -1.4902E-05  3.3844E-06 -1.7846E-05  0.0000E+00

 Slice at 3 index =   3

      197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      193 -3.8013E-05  1.7164E-05 -1.6456E-06  0.0000E+00
      189  2.7360E-05 -2.4250E-05 -1.5274E-06  0.0000E+00
      185 -2.2548E-05 -1.9376E-05 -3.4412E-06  0.0000E+00
      181  2.3751E-06 -2.0161E-05  2.6955E-05  0.0000E+00

 Slice at 3 index =   4

      217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      213  4.0474E-05 -3.7326E-05 -1.5804E-05  0.0000E+00
      209 -3.6522E-06  4.5986E-05 -1.6576E-05  0.0000E+00
      205  4.7000E-05  2.5916E-05 -2.2747E-05  0.0000E+00
      201 -1.3895E-05  2.4103E-05  2.6424E-05  0.0000E+00

 Slice at 3 index =   5

      237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      233  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      229  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      225  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      221  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component 3



 Slice at 3 index =   0

      257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      253  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
      249  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
      245  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
      241  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00

 Slice at 3 index =   1

      277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      273  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
      269  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
      265  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
      261  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00

 Slice at 3 index =   2

      297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      293  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
      289  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
      285  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
      281  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00

 Slice at 3 index =  3

      317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      313  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
      309  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
      305  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
      301  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00

 Slice at 3 index =  4

      337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      333  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
      329  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
      325  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
      321  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00

 Slice at 3 index =  5

      357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      353  7.0992E+01  6.6362E+01  6.1804E+01  0.0000E+00
      349  8.0165E+01  7.5554E+01  7.0973E+01  0.0000E+00
      345  8.9299E+01  8.4710E+01  8.0149E+01  0.0000E+00
      341  9.8520E+01  9.3905E+01  8.9317E+01  0.0000E+00



   BLOCK    =          8


d Component 1


 Slice at 3 index =  0

       17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       13 -2.5362E-02 -1.3423E-02  1.7593E-02  0.0000E+00
        9  7.3090E-03  2.8946E-03  5.6254E-04  0.0000E+00
        5  5.3183E-02  2.2381E-02  1.2745E-02  0.0000E+00
        1  2.3560E-02  2.3399E-02  9.1286E-03  0.0000E+00

 Slice at 3 index =  1

       37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       33 -2.5377E-02 -1.3474E-02  1.7613E-02  0.0000E+00
       29  7.3069E-03  2.8709E-03  5.4140E-04  0.0000E+00
       25  5.3160E-02  2.2333E-02  1.2781E-02  0.0000E+00
       21  2.3632E-02  2.3491E-02  9.0828E-03  0.0000E+00
```

```
 Slice at 3 index =  2

       57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       53 -2.5384E-02 -1.3400E-02  1.7593E-02  0.0000E+00
       49  7.2580E-03  2.8429E-03  5.3497E-04  0.0000E+00
       45  5.3190E-02  2.2370E-02  1.2842E-02  0.0000E+00
       41  2.3609E-02  2.3464E-02  9.0866E-03  0.0000E+00

 Slice at 3 index =  3

       77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       73 -2.5410E-02 -1.3415E-02  1.7605E-02  0.0000E+00
       69  7.3215E-03  2.8982E-03  5.0465E-04  0.0000E+00
       65  5.3194E-02  2.2330E-02  1.2801E-02  0.0000E+00
       61  2.3640E-02  2.3483E-02  9.1324E-03  0.0000E+00

 Slice at 3 index =  4

       97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       93 -2.5353E-02 -1.3442E-02  1.7590E-02  0.0000E+00
       89  7.2694E-03  2.8936E-03  5.3656E-04  0.0000E+00
       85  5.3187E-02  2.2341E-02  1.2765E-02  0.0000E+00
       81  2.3632E-02  2.3472E-02  9.0981E-03  0.0000E+00

 Slice at 3 index =  5

      117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      113 -2.5362E-02 -1.3445E-02  1.7575E-02  0.0000E+00
      109  7.3067E-03  2.8846E-03  5.4452E-04  0.0000E+00
      105  5.3170E-02  2.2368E-02  1.2752E-02  0.0000E+00
      101  2.3590E-02  2.3434E-02  9.1343E-03  0.0000E+00


d Component 2


 Slice at 3 index =  0

      137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      133  0.0000E+00  1.5099E-02  3.9806E-03  2.5862E-02
      129  0.0000E+00  2.7048E-02  3.4994E-02  7.6370E-03
      125  0.0000E+00  2.2633E-02  3.2656E-02 -8.3656E-03
      121  0.0000E+00 -8.1787E-03  2.3033E-02  8.4496E-03

 Slice at 3 index =  1

      157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      153  0.0000E+00  1.5133E-02  3.9101E-03  2.5841E-02
      149  0.0000E+00  2.7035E-02  3.4985E-02  7.6942E-03
      145  0.0000E+00  2.2591E-02  3.2665E-02 -8.3656E-03
      141  0.0000E+00 -8.1902E-03  2.3106E-02  8.4419E-03
 Slice at 3 index =  2

      177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      173  0.0000E+00  1.5106E-02  3.9253E-03  2.5860E-02
      169  0.0000E+00  2.7065E-02  3.4973E-02  7.6714E-03
      165  0.0000E+00  2.2648E-02  3.2654E-02 -8.3466E-03
      161  0.0000E+00 -8.1825E-03  2.3117E-02  8.3466E-03

 Slice at 3 index =  3

      197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      193  0.0000E+00  1.5079E-02  4.0092E-03  2.5841E-02
      189  0.0000E+00  2.7084E-02  3.5011E-02  7.5874E-03
      185  0.0000E+00  2.2655E-02  3.2608E-02 -8.3466E-03
      181  0.0000E+00 -8.2092E-03  2.3083E-02  8.3542E-03

 Slice at 3 index =  4

      217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      213  0.0000E+00  1.5099E-02  3.9635E-03  2.5795E-02
      209  0.0000E+00  2.7020E-02  3.5000E-02  7.6485E-03
      205  0.0000E+00  2.2644E-02  3.2642E-02 -8.3542E-03
      201  0.0000E+00 -8.1863E-03  2.3087E-02  8.4419E-03

 Slice at 3 index =  5

      237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      233  0.0000E+00  1.5116E-02  3.9558E-03  2.5877E-02
      229  0.0000E+00  2.7040E-02  3.4975E-02  7.6885E-03
      225  0.0000E+00  2.2617E-02  3.2639E-02 -8.3218E-03
      221  0.0000E+00 -8.2073E-03  2.3043E-02  8.4610E-03



d Component 3



 Slice at 3 index =  0

      257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      253  0.0000E+00 -1.2191E-05  9.3036E-06  1.6843E-05
      249  0.0000E+00  8.3190E-08  2.2529E-06 -1.6311E-05
      245  0.0000E+00 -1.5806E-05  2.4017E-05 -9.1576E-07
      241  0.0000E+00 -1.4447E-06  4.5056E-06  1.5859E-06

 Slice at 3 index =  1

      277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      273  0.0000E+00 -2.5209E-08  5.9270E-06 -1.4556E-05
      269  0.0000E+00 -1.5332E-06  7.7602E-07 -1.0890E-05
      265  0.0000E+00  4.9918E-06  1.0295E-05 -2.1590E-06
      261  0.0000E+00 -1.4526E-05  9.3750E-06  4.0280E-06

 Slice at 3 index =  2
```

```
      297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      293  0.0000E+00 -1.2551E-05  6.6363E-06  8.4508E-06
      289  0.0000E+00  3.3564E-06 -2.5639E-06  2.2464E-05
      285  0.0000E+00 -6.2371E-06 -4.5399E-06  2.1100E-06
      281  0.0000E+00  1.4288E-05 -1.4763E-05 -5.3102E-06

 Slice at 3 index =  3

      317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      313  0.0000E+00  1.4884E-06 -1.7604E-05  6.8460E-07
      309  0.0000E+00 -7.3151E-06  3.6447E-06 -5.8555E-06
      305  0.0000E+00  6.3148E-07 -6.2725E-06 -2.5823E-06
      301  0.0000E+00 -4.9884E-06  5.9328E-06  1.0668E-06

 Slice at 3 index =  4

      337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      333  0.0000E+00  1.6404E-05  1.6777E-06 -7.0883E-06
      329  0.0000E+00 -1.9819E-06 -5.1759E-06  1.3885E-05
      325  0.0000E+00  1.3497E-05 -1.6509E-05 -5.7639E-06
      321  0.0000E+00  8.6446E-06  7.3648E-06 -2.8715E-06

 Slice at 3 index =  5

      357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      353  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      349  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      345  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      341  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



   BLOCK     =              8



b Component 1



 Slice at 3 index =  0

       17  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       13  0.0000E+00  8.8302E-07 -2.3209E-05  2.9208E-05
        9  0.0000E+00  1.0404E-05 -2.9817E-05  1.7933E-05
        5  0.0000E+00  1.6159E-05 -1.2963E-05 -3.0997E-06
        1  0.0000E+00 -1.2654E-06  2.4682E-06 -1.8323E-05

 Slice at 3 index =  1

       37  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       33  0.0000E+00  2.3573E-05 -2.0904E-05  1.8218E-05
       29  0.0000E+00 -1.3903E-05  1.1779E-05 -1.2548E-05
      25  0.0000E+00 -4.8627E-06  1.2323E-05 -4.5087E-06
      21  0.0000E+00 -2.0557E-05 -2.4928E-06  3.0823E-05

 Slice at 3 index =  2

      57  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      53  0.0000E+00 -2.1005E-05  3.7770E-05 -1.1735E-05
      49  0.0000E+00  6.5792E-06 -1.5740E-06 -2.8962E-05
      45  0.0000E+00 -4.1261E-06 -3.9556E-05  2.6334E-07
      41  0.0000E+00  2.0751E-05 -2.0743E-05 -7.1957E-06

 Slice at 3 index =  3

      77  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      73  0.0000E+00 -9.7880E-07 -6.4148E-06 -1.3927E-05
      69  0.0000E+00 -2.5824E-05 -5.2675E-06  3.2856E-05
      65  0.0000E+00 -1.1134E-05  3.4229E-05  1.6520E-05
      61  0.0000E+00  1.3009E-06  1.7030E-05  1.0426E-05

 Slice at 3 index =  4

      97  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      93  0.0000E+00  4.5964E-06 -8.1385E-06  5.4895E-06
      89  0.0000E+00 -2.2262E-06  6.1379E-06 -6.2501E-06
      85  0.0000E+00 -7.3698E-06 -1.0066E-05 -1.1413E-05
      81  0.0000E+00 -1.9288E-05 -1.0162E-05 -1.0172E-05

 Slice at 3 index =  5

     117  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     113  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     109  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     105  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     101  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component  2



 Slice at 3 index =  0

     137  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     133  4.3772E-08 -1.9637E-05 -5.0054E-05  0.0000E+00
     129  1.0459E-05  6.4871E-06 -1.3152E-05  0.0000E+00
     125 -1.6727E-06  2.4023E-05 -3.1953E-05  0.0000E+00
     121 -2.9290E-06 -1.5764E-05 -9.8152E-06  0.0000E+00

 Slice at 3 index =  1

     157  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     153 -2.0436E-05 -3.3095E-05 -6.8184E-05  0.0000E+00
     149  1.9581E-05  2.6241E-05  2.0930E-05  0.0000E+00
     145 -3.1121E-05 -1.1005E-05 -1.1749E-05  0.0000E+00
```

```
     141 -1.2280E-05  2.2628E-05  2.8815E-06  0.0000E+00

 Slice at 3 index =  2

     177  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     173  2.4166E-05 -3.7792E-05  2.2228E-05  0.0000E+00
     169 -4.0052E-05 -2.1192E-05  8.0778E-05  0.0000E+00
     165 -8.4955E-06  1.8258E-05  1.2550E-05  0.0000E+00
     161  4.4027E-05 -2.0227E-05 -2.1074E-05  0.0000E+00

 Slice at 3 index =  3

     197  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     193 -5.7669E-05  4.7082E-05  3.6919E-05  0.0000E+00
     189  6.8848E-05  2.9187E-05 -5.9769E-05  0.0000E+00
     185  4.0771E-05 -3.5428E-05 -1.1066E-05  0.0000E+00
     181 -4.1370E-05  2.6091E-05  1.2620E-05  0.0000E+00

 Slice at 3 index =  4

     217  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     213 -2.1977E-05  9.4390E-06  1.4479E-05  0.0000E+00
     209 -6.7940E-06  1.0210E-06  2.1192E-05  0.0000E+00
     205 -1.7494E-05  9.9838E-07  1.2436E-05  0.0000E+00
     201  2.3616E-05  1.1479E-05  3.4054E-06  0.0000E+00

 Slice at 3 index =  5

     237  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     233  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     229  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     225  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     221  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00



b Component  3



 Slice at 3 index =  0

     257  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     253  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
     249  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
     245  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
     241  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00

 Slice at 3 index =  1

     277  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
     273  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
     269  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
     265  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
     261  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00
```

```
Slice at 3 index =  2

      297  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      293  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
      289  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
      285  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
      281  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00

Slice at 3 index =  3

      317  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      313  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
      309  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
      305  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
      301  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00

Slice at 3 index =  4

      337  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      333  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
      329  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
      325  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
      321  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00

Slice at 3 index =  5

      357  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
      353  1.8014E+02  1.6948E+02  1.5882E+02  0.0000E+00
      349  1.6636E+02  1.5571E+02  1.4502E+02  0.0000E+00
      345  1.5261E+02  1.4196E+02  1.3125E+02  0.0000E+00
      341  1.3891E+02  1.2820E+02  1.1750E+02  0.0000E+00
```

ANNEXES

A LPM3 Benchmarking Results

AEA/TYKB/31878/TN/6

THE 3-D GENERAL GEOMETRY PIC SOFTWARE FOR DISTRIBUTED MEMORY MIMD COMPUTERS:

LPM3 Benchmark Results on the Intel Paragon and iPSC/860

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26 July 1994

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Contents

THE 3-D GENERAL GEOMETRY PIC SOFTWARE FOR DISTRIBUTED MEMORY MIMD COMPUTERS:

LPM3 Benchmark Results on the Intel Paragon and iPSC/860

Roger W. Hockney

26 July 1994

Abstract

A benchmark version of the 3D MIMD PIC code is described, and measurements are reported for the Intel iPSC/860 and Paragon XP/S 140. These show an almost linear speedup and sizeup from the one processor performance on the 8 and 64 block problems. The 512 block problem shows a modest fall off from linear performance scaling for more than 256 processors, and the 4096 block problem for more than 1366 processors. We conclude that the code can make efficient use of many hundreds of processors on a large massively parallel computer.

1 Background

In order to demonstrate the parallel performance of the new MIMD PIC code, a version has been prepared as a benchmark program and run on the Intel Paragon at the Sandia National Laboratory, Albuquerque, and on an Intel iPSC/860. This benchmark version is known as LPM3 (Local Particle Mesh benchmark # 3) can be used in a standard way to test the capabilities of the code on other computers available to the USAF (e.g. the IBM SP1/2 facility at Maui). It therefore also provides a standard performance comparison between the different computers.

2 LPM3 Benchmark

The earlier LPM2 benchmark which was provided to the USAF in 1993 took a typical two-dimensional MILO geometry to test the parallel capabilities of the earlier code on modestly parallel computers, say up to 32 or 64 processors. In contrast, LPM3 is designed to exploit to the maximum the capabilities of the much larger Massively Parallel Systems (MPPs) with more than a thousand processors that are now becoming available to the USAF, such as the Intel Paragon and IBM SP/2. To do this, the benchmark problem chosen has to be three dimensional in order to contain enough parallelism to use a large MPP, and must also be freely and easily scalable in size to expand to the size of any MPP. The problem must also be physically realistic and representative of the problems for which the code is designed. Our choice for LPM3 was a triply periodic three-dimensional electron plasma.

The plasma space is divided into blocks, each of which contains 512 particles representing the electrons, and 64 elements on which the fields are calculated. From the point of view of load balancing on the parallel computer, the block is the smallest unit that can be allocated amongst the processors. The problem size is measured by number of blocks N_b, and four problem sizes have been used with respectively $N_b = 8, 64, 512, 4096$. These correspond respectively to numbers of particles $N_p = 4K, 32K, 256K, 2M_2$ where $K = 1024$ and $M_2 = K^2$. The timestep is such that about ten percent of the particles leave each block and enter neighbouring blocks during a timestep. A run of 100 timesteps is chosen as the benchmark test because this can be done in a few minutes for problem sizes and numbér of processors of interest (timestep per second in the range 0.1 to 10), and the conservation of total number of particles is used as a validity check.

The program also prints every ten steps the number of particles in block one and the number of particles leaving block one in a timestep. Because the particles in each block are loaded with identical positions relative to the block edges and with identical velocities, the number of particles in each block should remain at 512 (for every particle leaving there is an image particle entering the block). This is generally true up to 90 steps or so, but small differences in rounding errors in the edge tests mean that the number of particles in each block varies slightly from 512 at the end of 100 steps. This is not considered an error unless the total number of particles in the whole plasma changes (i.e. particles are being lost from the system as a whole). This has never been observed with the LPM3 code.

There are two different versions of the benchmark code, which are selected by the value of the last input variable MXPASW. The per-patch version sends a separate message for every patch in the system, and there are 9 patches for every block. In the per-process version, on the other hand, the patch messages are assembled and sorted in a buffer so that only one message is sent to every other process to which a given process is attached. The per-process code may send 10 or 100 times fewer messages than the per-patch version. The per-process version should be significantly faster than the per-patch version on computers with a high message startup time or latency. For computers with low latency there will be little difference between the versions.

3 LPM3 Results

All the benchmark measurements obtained are shown in Fig. 1. The results are expressed as Temporal performance in units of timestep per second. This is a clear and unambiguous metric which expresses exactly what a program user wishes to maximise. We have deliberately not used the sometimes popular metrics of Parallel Speedup and Efficiency because these are not absolute measures and cannot be used correctly to compare the performance of different computers. Neither have we expressed the results as Megaflop per second (Mflop/s), because this would make the curves lie closely on top of each other, and disguise the actual time of computation from the reader. In our units of timestep per second (tstep/s), calculations which take the same time lie at the same height in the graph, and faster calculations which take less time lie higher in the graph. These statements would not necessarily be true if the results were expressed as speedup or in megaflop per second.

For each block size there are two pairs of curves. The pair closest to the theoretical dotted line is that for the Intel Paragon running under the Sandia SUNMOS 1.4.8 operating system, and the pair about 60 percent lower and slower are for the iPSC/860 running under the NX release 3.3.2 operating system. For each computer the open symbols are the measured values using the per-process code and the corresponding filled symbols for the per-patch code. The fact that the curves for both versions are almost the same on both the computers, means that message latency is not a problem with the Paragon under SUNMOS or with the iPSC/860. The latency has separately been measured using the COMMS1 'pingpong' benchmark to be about 80μs for both these computers.

The dotted lines are theoretical perfect linear scaling predictions for the Paragon, calculated from the one-processor performance on the eight block problem. This scaling assumes that performance is proportional to the number of processors, and inversely proportional to the problem size. Thus we are saying that using p-times as many processors should ideally allow one to compute an existing problem p-times faster (the speedup), or solve a problem p-times bigger in the same time (the sizeup). Alternatively, of course, the increase in number of processors should be able to be used to obtain a combination of speedup and sizeup. The stepwise nature of the measured performance curves arises due to load imbalance when the number of blocks is not exactly divisible by the number of processors. If we concentrate attention on the best performance figures which correspond to perfect load balance, when every processor is computing the same number of blocks, we find that the measured performance is within 80 percent of the ideal linear scaling except for the 512 block case for greater than 256 processors, and the 4096 block case for more than 1366 processors. For these cases with larger numbers of processors, performance saturation is beginning to be seen.

For the set of cases shown in fig. 1 it is evident that there is not enough parallelism in the problem to obtain more than about 10 timestep per second. The 8 block problem can at most use 8 processors, and there is no further possibility of using more processors to speedup that problem. The best we can do with the extra processors is to solve bigger problems in about the same time, and this is seen for the cases of $N_b = 64, 512, 4096$, none of which exceed 10 tstep/s however many processors are used.

4 Final Remarks and Recommendations

The measurements using the LPM3 benchmark version of the new 3D PIC code show almost linear speedup and sizeup of performance with the number of processors up to about 256, after which noticeable performance degradation from the ideal is observed. Further runs on the Intel Paragon are intended for the same problem but with an eight times smaller block size. This should allow more processors to be used to increase the performance of each problem size. After this it is proposed that the same tests be run on the IBM SP1 and SP2 at the USAF Computer Center in Maui. This will give a very interesting comparison between the IBM and Intel systems, as well as exercising the new code on a different manufacturer's equipment.

Further it is recommended that the benchmark code be sanitised of proprietory features so that it can be put in the public domain and become part of an internationally recognised benchmark set, such as that recently setup by the PARKBENCH committee. If this were done, the performance of the code would become known on most new computers as the manufacturers and others run the standard benchmarks, and enter the results in the publically available data-base, which will be accessible via the Mosaic interface to the World-Wide-Web.

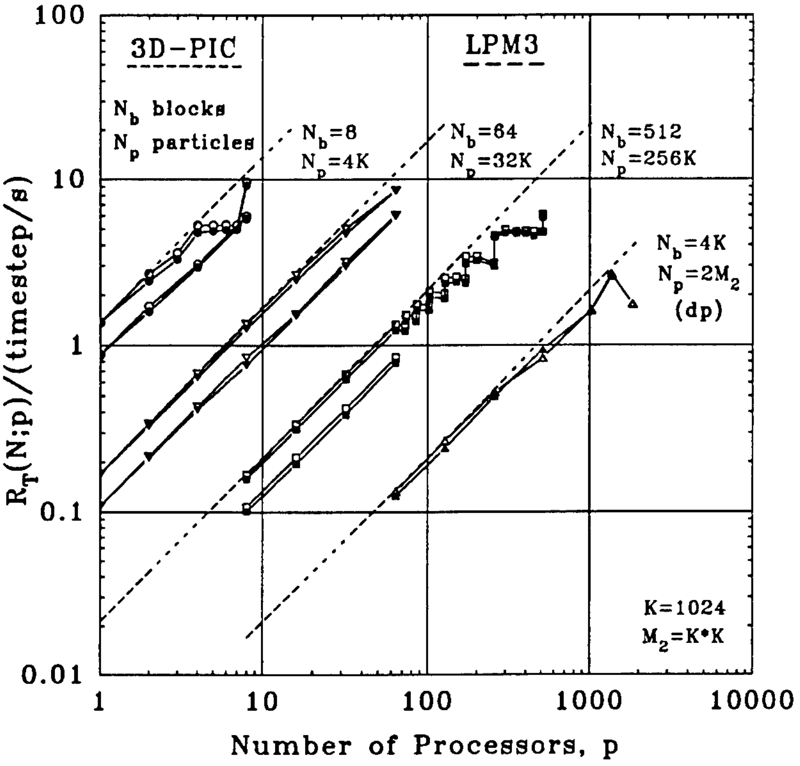

Figure 1: *Temporal Performance of the LPM3 benchmark measured in units of timestep per second, for four problem sizes and up to 1840 processors on the Sandia Laboratory's Intel Paragon XP/S 140 (upper pair of curves which are close to the dotted lines), and up to 64 processors on the Intel iPSC/860 (lower pair of curves). The open symbols are measured values for the per-process code, and the filled symbols are the measured values for the per-patch code (see text). The dotted lines are theoretical perfect linear scaling predictions for the Paragon, calculated from the one-processor performance on the eight block problem. This scaling assumes that performance is proportional to the number of processors, and inversely proportional to the problem size. The stepwise nature of the performance curves arises due to load imbalance when the number of blocks is not exactly divisible by the number of processors.*

B The System of Dimensionless Units

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THE SYSTEM OF DIMENSIONLESS UNITS

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THE SYSTEM OF DIMENSIONLESS UNITS

W Arter

September 1994

Abstract

This note outlines the revised system of internal units used in the kernel of the 3-D general geometry PIC software.

It is sufficient to make Maxwell's equations dimensionless in an orthogonal coordinate system as the resulting rules must apply to the non-orthogonal case. Let fundamental units be electric field E_0, velocity c and time T. It is convenient to introduce the auxilliary quantity

$$L = cT. \tag{1}$$

Note T will normally be set so that

$$T = \Delta t, \tag{2}$$

where Δt is the timestep calculated as

$$\Delta t = \frac{2C_0}{c\sqrt{3}\Gamma} \tag{3}$$

where $C_0 \leq 1$ is a user specified constant and Γ (defined in the Annex on Dispersion and Stability) contains geometrical information. The basis vector

$$\mathbf{e}_1 = \frac{\partial \mathbf{x}}{\partial \bar{x}^1}, \tag{4}$$

hence for the orthogonal discrete system where

$$x = h_1 \bar{x}^1, \tag{5}$$

so that $\bar{x}_1$ runs over 0 to 1 along a cell boundary, it follows that

$$\mathbf{e}_1 = h_1 \hat{\mathbf{x}}_1 \tag{6}$$

where $\hat{\mathbf{x}}_1$ is the unit vector in the 1-direction. From its definition also

$$\mathbf{e}^1 = \hat{\mathbf{x}}_1 / h_1. \tag{7}$$

There follows the results that

$$\mathbf{D} = D(j)\hat{\mathbf{x}}_j = h_{(j)}D^j \cdot \frac{\mathbf{e}_j}{h_{(j)}} = D^j\mathbf{e}_j \tag{8}$$

$$= \frac{D_j}{h_{(j)}} h_{(j)}\mathbf{e}^j = D_j\mathbf{e}^j. \tag{9}$$

Suppose $D(j)$ to have units D_0, eqs (8) and (9) imply that

$$[D_j] = D_0/L \tag{10}$$

and

$$[D_j] = D_0L, \tag{11}$$

where the square brackets denote the function that returns the dimensions of the enclosed argument.

The relations between the dimensions of physical components follow from the continuum Maxwell equations and are

$$D_0/T = H_0/L = J_0, \tag{12}$$

$$D_0/L = \rho_0, \tag{13}$$

$$B_0/T = E_0/L, \tag{14}$$

$$D_0 = \epsilon_0 E_0, B_0 = \mu_0 H_0. \tag{15}$$

It also follows that

$$J_0 = \epsilon_0 E_0/T, \rho_0 = \epsilon_0 E_0/L \tag{16}$$

and

$$B_0 = E_0/c, c^2 = 1/(\mu_0\epsilon_0). \tag{17}$$

The discrete equations are framed in terms of d^i, H_i etc. It suffices to treat a single component of each vector field. Recall that

$$\mathbf{d} = \sqrt{g}\mathbf{D}. \tag{18}$$

Now $\sqrt{g}$ has dimensions of volume, hence using (10) the units of d^1 are $L^3 \cdot (D_0/L)$, ie

$$[d^1] = L^2\epsilon_0 E_0 \tag{19}$$

It follows that

$$[Q] = [I^i] = [H_i] = [d^i] = L^2\epsilon_0 E_0 \tag{20}$$

since all quantities in the difference equations representing Gauss' Law and Ampere's equation must have the same dimensions. Since

$$\mathbf{b} = \sqrt{g}\mathbf{B} \tag{21}$$

it follows similarly that

$$[b^i] = L^2 E_0/c \tag{22}$$

and the discretised Faraday's Law implies also

$$[E_i] = L^2 E_0/c. \tag{23}$$

The dimensions of G^E and G^H follow from the constitutive relations

$$[G^E_{ij}] = \frac{[E_1]}{[d^1]} = \frac{1}{\epsilon_0 c}, \tag{24}$$

$$[G^H_{ij}] = \frac{[H_1]}{[b^1]} = \epsilon_0 c, \tag{25}$$

To obtain dimensions for ϕ and $\mathbf{A}$ use the definition

$$\mathbf{E} = -\nabla\phi - \frac{\partial \mathbf{A}}{\partial t}, \tag{26}$$

yielding

$$[\phi] = LE_0 \tag{27}$$

and

$$[A_i] = L^2 E_0/c \tag{28}$$

Lastly there are the boundary conditions to treat. Setting $d^i = \epsilon_0 C^i$ implies

$$[C^i] = L^2 E_0, \tag{29}$$

As might be expected on general grounds, since $(\epsilon_0 c)^{-1}$ is the impedance of free space, it can be shown that for the surface impedance of walls

$$[Z] = \frac{1}{\epsilon_0 c}. \tag{30}$$

The above set of units is given in terms of E_0. It is, however, convenient to have an expression for E_0 in terms of more fundamental quantities. Anticipating PIC code work we take

$$E_0 = 2\frac{m_e}{\mid e \mid}\frac{c}{T} \tag{31}$$

where m_e is the mass of an electron and $\mid e \mid$ is the absolute value of the charge on an electron. The units employed are summarised in Table 1.

Table 1: Dimensionless units employed in the code. T is a shorthand for Δt obtained using eq (3) and E_o is given by eq (31).

Quantity	Units
$\mathbf{E}$	E_0
$\mathbf{B}$	E_0/c
$Length$	cT
$Time$	T
$Velocity$	c
d^j, H_j, I^j, Q	$\epsilon_0 E_0 (cT)^2$
b^j, E_j	$E_0 cT^2$
ϕ	$E_0 cT$
A_j	$E_0 cT^2$
C^j	$E_(cT)^2$
Z	$1/(\epsilon_0 c)$
$\mathbf{e}_j$	cT
$\mathbf{e}^j$	$1/(cT)$
G^E_{ij}	$1/(\epsilon_0 c)$
G^H_{ij}	$\epsilon_0 c$

C Dispersion and Stability Analysis for Maxwell's Equations

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DISPERSION AND STABILITY ANALYSIS FOR MAXWELL'S EQUATION

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DISPERSION AND STABILITY ANALYSIS FOR MAXWELL'S EQUATION

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Abstract

This note derives the stability criterion used to specify the timestep used for integration of the field equations in the 3-D general geometry PIC code PIC3D.

The discrete version of Maxwell's equations solved by PIC3D may be written

$$\partial_t b^i = -e^{ijk}\partial_j \overline{G^E_{k\ell} d^\ell}, \tag{1}$$

$$\partial_t d^i = e^{ijk}\partial_j \overline{G^H_{k\ell} b^\ell}, \tag{2}$$

where the overbar on the expressions containing G^E and G^H denotes that a 4-point average is used for terms involving off-diagonal $G^{E,H}$. Assuming that G^E and G^H are uniform and constant, we seek a solution to eqs (1) and (2) of form

$$d^{in} = d^{io} z^{2n} e^{i\bar{k}_j \bar{x}^j}, \tag{3}$$

$$b^{in} = b^{io} z^{2n+1} e^{i\bar{k}_j \bar{x}^j}, \tag{4}$$

where

$$z = e^{s\Delta t}. \tag{5}$$

The operators ∂_t and ∂_j are such that they can be replaced as follows

$$\partial_t \rightarrow (z^2 - 1), \tag{6}$$

$$\partial_j \rightarrow iK_j, \tag{7}$$

where

$$K_j = \sin\frac{\bar{k}_j}{2}. \tag{8}$$

The 4-point average leads to the appearance of a factor

$$\cos\frac{\bar{k}_i}{2}\cos\frac{\bar{k}_j}{2} = \surd(1 - K_i^2)(1 - K_j^2) \tag{9}$$

wherever off-diagonal G are present in eqs (1) and (2), and $\tilde{G}$ will denote G with this factor applied.

Combining equations (1) to (8) gives

$$\det(\mu\delta^i_p - \tilde{M}^i_p) = 0, \tag{10}$$

where

$$\mu = \frac{(z^2-1)^2}{z^2}, \tag{11}$$

$$\tilde{M}^i_p = A^{ki}\tilde{G}^H_{k\ell}A^{n\ell}\tilde{G}^E_{np}, \tag{12}$$

and

$$A^{ki} = e^{kij}K_j \tag{13}$$

Stability of the discrete system requires $\mid z \mid \leq 1$ which may be shown to be equivalent to

$$-4 \leq \mu \leq 0. \tag{14}$$

No completely general result is available for the circumstances under which solutions of eq (10) satisfy (14). We treat the problem by considering a number of special cases.

Case (i)

$$G^E_{ij} \propto G^H_{ij} \tag{15}$$

Under this assumption

$$\tilde{M}^i_p = Q^i_\ell Q^\ell_p \frac{(\Delta t)^2 C_{\epsilon\mu}}{\mu_o \epsilon_o g}, \tag{16}$$

where

$$Q^i_\ell = e^{ijk}K_j\tilde{g}_{k\ell}, \tag{17}$$

$C_{\epsilon\mu}$ is related to the constant of proportionality in (15) and may be taken as unity, and in an isotropic medium, g_{ij} is the metric tensor (so $\tilde{g}_{ij}$ contains factors of the form (9)).

If Q has eigenvalues $q^{(p)}$, since $\tilde{M} \propto Q^2$, by a well-known result in linear algebra, the eigenvalues of $\tilde{M}$ satisfy

$$\mu^{(p)} = (q^{(p)})^2 \frac{c^2 \Delta t^2}{g}. \tag{18}$$

Using the Reduce computer algebra package [1], it may be shown that

$$\begin{aligned} -q^2 &= K_1^2(\tilde{g}_{22}\tilde{g}_{33} - \tilde{g}_{23}^2) + K_2^2(\tilde{g}_{11}\tilde{g}_{33} - \tilde{g}_{13}^2) + K_3^2(\tilde{g}_{11}\tilde{g}_{22} - \tilde{g}_{12}^2) \\ &+ 2K_1K_2(\tilde{g}_{13}\tilde{g}_{23} - \tilde{g}_{12}\tilde{g}_{33}) + 2K_1K_3(\tilde{g}_{12}\tilde{g}_{23} - \tilde{g}_{13}\tilde{g}_{22}) \\ &+ 2K_2K_3(\tilde{g}_{12}\tilde{g}_{13} - \tilde{g}_{23}\tilde{g}_{11}). \end{aligned} \tag{19}$$

If the twiddles in eq (19) are dropped, the stability criterion of Lee, Palandech and Mittra [2] is found. However, the role of the 4-point averages is significant. We use identities of the type

$$K_1\sqrt{1-K_1^2} = \sin\frac{\bar{k}_1}{2}\cos\frac{\bar{k}_1}{2} = \frac{1}{2}\sin\bar{k}_1, \tag{20}$$

$$K_1^2 = \frac{1}{2}(1-\cos\bar{k}_1), \tag{21}$$

$$1-K_1^2 = \frac{1}{2}(1+\cos\bar{k}_1), \tag{22}$$

and write

$$c_i = \cos\bar{k}_i, s_i = \sin\bar{k}_i. \tag{23}$$

In $2-D$, assuming isotropic permeability and permittivity, it may then easily be shown that equivalent of eq (19) is extremal on the boundary of the c_i domain, ie q^2 is least when $c_1 = -1$ and $s_1 = 0$. Assuming that (19) also is extremal on the boundary, ie at

$$c_1 = c_2 = c_3 = -1, s_1 = s_2 = s_3 = 0, \tag{24}$$

the stability criterion

$$c\Delta t\sqrt{\left(\frac{g_{22}g_{33}+g_{11}g_{33}+g_{11}g_{22}}{g}\right)} \leq 2 \tag{25}$$

is obtained. Note that the 4-point averages have removed the explicit off-diagonal terms found in Lee, Palandech and Mittra; however they still appear, implicitly, in g.

Case (ii) No proportionality between G^E_{ij} and G^H_{ij}.

Attention now has to focus on $\tilde{M}^i_p$, since in general $\tilde{M} = QR$ does not imply $\mu^{(p)} = q^{(p)}r^{(p)}$ where $r^{(p)}$ are the eigenvalues of R. The determinantal equation is readily formed by employing Reduce. We use the lack of off-diagonal terms above to support the step, whereby the $3-D$ determinantal equation is made tractable by restricting attention to the case where $\tilde{G}^E_{ij}$ and $\tilde{G}^H_{ij}$ are diagonal. It is convenient to denote the scaled diagonal elements of these tensors by e_i and h_i respectively. Suppose once again that the extremal μ is found on the boundary of c_i space, then

$$(\mu^s)^2 + \mu^s t_r + \Delta = 0 \tag{26}$$

where μ is scaled so that

$$\mu^s = \frac{\mu g}{c^2\Delta t^2}, \tag{27}$$

and

$$t_r = h_3e_2 + h_2e_3 + h_3e_1 + h_1e_3 + h_1e_2 + h_2e_1, \tag{28}$$

$$\Delta = (h_2h_3 + h_1h_3 + h_1h_2)(e_2e_3 + e_1e_3 + e_1e_2). \tag{29}$$

Analysis of eq (26) shows that inequality (14) holds provided a technical condition applies requiring that μ be real, which we neglect, and that

$$0 < 2t_r - \Delta < 8. \tag{30}$$

Introducing

$$a_1 = h_2e_1, a_2 = h_1e_2, \tag{31}$$

$$a_3 = h_1e_3, a_4 = h_3e_1, \tag{32}$$

$$a_5 = h_2e_3, a_6 = h_3e_2, \tag{33}$$

eq (29) becomes

$$\Delta = (a_3 + a_5)(a_4 + a_6) + a_1(a_3 + a_6) + a_2(a_4 + a_5) + a_1a_2 \tag{34}$$

The expression $2t_r - \Delta$ is a quadratic in the a_i and has a local minimum when all a_i are equal, say to a, hence

$$2t_r - \Delta = 12a - 9a^2. \tag{35}$$

The expression (35) is positive provided

$$a < \frac{4}{3}. \tag{36}$$

Investigation of other extrema shows that they give less restrictive criteria than (36).

Introducing the in vacuo quantity

$$\mathcal{G}_{ij} = g_{ij}/\sqrt{g}, \tag{37}$$

relation (36), remembering the scaling (27), implies that

$$c\Delta t\sqrt{\Gamma} < \frac{2}{\sqrt{3}} \tag{38}$$

where

$$\Gamma = \max(\mathcal{G}^{\mathrm{E}}_{11}\mathcal{G}^{\mathrm{H}}_{22}, \mathcal{G}^{\mathrm{E}}_{22}\mathcal{G}^{\mathrm{H}}_{11}, \mathcal{G}^{\mathrm{E}}_{11}\mathcal{G}^{\mathrm{H}}_{33}, \mathcal{G}^{\mathrm{E}}_{33}\mathcal{G}^{\mathrm{H}}_{11}, \mathcal{G}^{\mathrm{E}}_{22}\mathcal{G}^{\mathrm{H}}_{33}, \mathcal{G}^{\mathrm{E}}_{33}\mathcal{G}^{\mathrm{H}}_{22}), \tag{39}$$

where $\mathcal{G}$ contains only geometrical and relative permittivity / permeability information for a general medium.

Comments The criterion (38) is employed in the code. In some special cases it is clearly unduly restrictive. It has not been rigorously derived. However it is plausible that it ensures stability in general geometry. Moreover, since general geometry and anisotropy of the medium both correspond to significant off-diagonal entries in G_{ij}, it is plausible that (38) also ensures stability in physically realisable anisotropic media.

References

[1] A.C. Hearn, *Reduce User's Manual*, Rand Corporation, Santa Monica.

[2] J.-F. Lee, R. Palandech and R. Mittra, IEEE Trans. Microwave Theory and Techniques 40(2)346-352 (1992).

D 3DPIC Diagnostics

AEA/TYKB/31876/TN/9

3DPIC DIAGNOSTICS

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3DPIC DIAGNOSTICS

N J Brealey, J W Eastwood and W Arter

September 1994

Abstract

This Note contains a specification of diagnostics selection, the data structure for the diagnostics and the algorithms for the diagnostics collection and output in the 3DPIC codes.

1 Introduction

This note describes the diagnostics used by the 3DPIC codes. It concentrates on timeseries diagnostics which are compatible with the TSD file format and **mpictim**[1].

Each process produces its own set of diagnostics files which are then merged by a post processor to produce diagnostics files for the whole simulation. There will usually be 4 TSD files for each problem containing data for points, lines, surfaces and volumes which correspond to the 'surfaces' in the TSD file format. There will generally be no TSD style 'audit' data items.

2 Specification of Diagnostics

This section describes the tagged input form for specifying diagnostics.

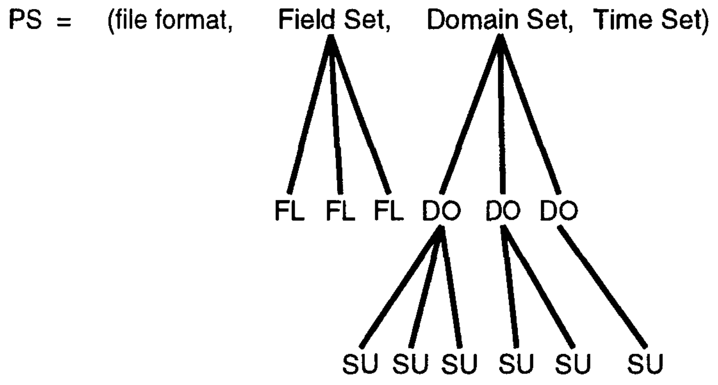

Figure 1: Plot Set

2.1 Plot Set (PS)

A Plot Set is specified by a PS tag followed by a file format name (`'tsd'` for a TSD file), the name of a Field Set, the name of a Domain Set and the name of a Time Set.

The tagged format is:

```
PS␣file-format␣Field-Set␣Domain-Set␣Time-Set
```

A TSD file is produced for each Plot Set on each process so that the number of TSD files is the product of the number of processes and the number of Plot Sets. A post processor will combine the TSD files from different processes so that there is only one merged file for each Plot Set.

If a more flexible tagged file format is used (e.g. HDF) there need only be one file per process. If message passing is added there need only be one file for all processes.

2.1.1 Field Set (FS)

The Field Set specifies a list of Fields (FL).

```
FS␣fieldset-name␣field-name1␣field-name2␣field-name3␣...
```

2.1.2 Field Specification

The FieLd specification format is:

```
FL␣field-name␣specification-string
```

The specification string specifies which point quantities, line integrals, surface integrals or volume integrals are required:

1. Point values of scalars may be sampled. The scalar quantities are E1, E2, E3, H1, H2, H3 (components of the electromagnetic fields) $n1$, $n2$, ... (the numbers of particles of each species), $\mathbf{B}\cdot\mathbf{H}/2$, $\mathbf{E}\cdot\mathbf{D}/2$ or $\mathbf{j}\cdot\mathbf{E}$. These quantities are represented by strings such as `'E.D/2'`, `'j.E/2'`, `'B.H/2'`.

2. Line integrals are $\int \mathbf{E}\cdot d\mathbf{l}$ or $\int \mathbf{H}\cdot d\mathbf{l}$ and are represented by the strings `'int E.dl'` or `'int H.dl'`.

3. Surface integrals are $\int \mathbf{D}\cdot d\mathrm{S}$, $\int \mathbf{B}\cdot d\mathrm{S}$ or $\int \mathbf{j}\cdot d\mathrm{S}$ and are represented by the strings `'int D.dS'`, `'int B.dS'` or `'int j.dS'`.

4. Volume integrals are $\int \psi dV$ where ψ may be one of $n1$, $n2$, ..., $\mathbf{B}\cdot\mathbf{H}/2$, $\mathbf{E}\cdot\mathbf{D}/2$ or $\mathbf{j}\cdot\mathbf{E}$. The integrals are represented by expressions such as `'int n1 dV'`, `'int E.D/2 dV'`, `'int j.E dV'` etc.

Vector point quantities, **E**, **B**, **D**, **H** and **j**, are also allowed in general but are not supported for TSD files.

2.1.3 Domain Set (DS)

The Domain Set specifies a list of Domains (DO). Each Domain Set belongs to exactly one Plot Set.

```
DS␣domainset-name␣domain-name1␣domain-name2␣domain-name3␣...
```

2.1.4 Domain (DO)

The DOmain specifies a list of SUbdomains (SU). Each Domain belongs to exactly one Domain Set.

```
DO␣domain-name␣subdomain-name1␣subdomain-name2␣subdomain-name3␣...
```

2.1.5 Subdomain (SU)

The SUbdomain specifies a cuboidal subset of a block. Each Subdomain belongs to exactly one Domain.

```
SU␣subdomain-name␣block-name␣d␣o␣x
```

The `block-name` is the name of a block, `o` and `x` are the coordinates of the corners of the subdomain in local normalised curvilinear coordinates and `d` is a triple of the integers (1, 2, 3, -1, -2, -3) which gives the directions for evaluating components and integrals. `d`(1) gives the direction for line integrals, `d`(1) and `d`(2) give the first and second directions for the vectors in a surface. `d`(3) is the normal direction of a surface.

The o and x points will be converted to element numbers by the preprocessor and the block name will be converted to a block number. All diagnostic quantities will be evaluated at element centres.

2.1.6 Time Set (TS)

The Time Set specifies the times at which output is required. Each Time Set belongs to exactly one Plot Set.

```
TS␣timeset-name␣start-time␣end-time␣output-interval␣...
```

The start time, end time and output interval are given as real numbers.

3 Data Structure

The following COMMON blocks are used to specify the diagnostics:

3.1 Plot Set Data

```
/COMPS/
I MAXPS               maximum number of plot sets
I NPS                 **number of plot sets
IA NFSPS(MAXPS)        **numbers of field sets in each plot set
IA NDSPS(MAXPS)        **numbers of domain sets in each plot set
IA NTSPS(MAXPS)        **numbers of time sets in each plot set
RA WSPSCL(MAXDOS,MAXFLS) scalar workspace
/CHAPS/
AA CFMTPS*32(MAXPS)   **file format for each plot set
```

3.2 Field Set Data

```
/COMFS/
I MAXFS               maximum number of field sets
I MAXFLS              maximum number of fields per field set
I NFS                 **number of field sets
IA MFLFS(MAXFS)        **number of fields in each field set
IA NPSFS(MAXFS)        **plot sets of each field set
```

3.3 Domain Set Data

```
/COMDS/
I MAXDS               maximum number of domain sets
I MAXDOS              maximum number of domains per domain set
I NDS                 **number of domain sets
IA MDODS(MAXDS)        **number of domains in each domain set
IA NPSDS(MAXDS)         **plot sets of each domain set
```

3.4 Time Set Data

```
/COMTS/
I MAXTS               maximum number of time sets
I NTS                 **number of time sets
RA TIMETS(6,MAXTS)     **start, stop, output, average times, time zero, time unit
IA NSTPTS(6,MAXTS)     **start, stop, output, average steps, step zero
LA LCOLTS(MAXTS)       collect flags
LA LOUTTS(MAXTS)       output flags
IA NPSTS(MAXTS)        **plot sets of each time set
RA TOTLST(MAXTS)       last output times
/CHATS/
AA CNLTIM*64(MAXTS)    **long names of time
AA CNSTIM*8(MAXTS)     **short names of time
AA CNUTIM*8(MAXTS)     **units of time
AA CNURAT*8(MAXTS)     **units of rate of change
AA CNUFRQ*8(MAXTS)     **units of frequency
```

3.5 Domain Data

```
/COMDO/
I MAXDO                 maximum number of domains
I MAXSUD                maximum number of subdomains per domain
I NDO                   **number of domains
IA NDSDO(MAXDO)          **domain sets of each domain
IA NCOLDO(MAXDO)         **domain colours
RA SLIMDO(2,MAXDO)       **domain arc length limits
RA SCLDO(2,MAXDO)        **zero and unit of arc length
/CHADO/
AA CNLDO*64(MAXDO)      **long names of domains
AA CNSDO*8(MAXDO)       **short names of domains
```

3.6 Field Data

```
/COMFL/
I MAXFL                 maximum number of fields
I NFL                   **number of fields
RA SCLFL(2,MAXFL)       **zero and unit of field
IA NFSFL(MAXFL)         **field sets of each field
IA NCOLFL(MAXFL)        **field colours
RA FLIMFL(2,MAXFL)      **field limits
/CHAFL/
AA CFLSPC*64(MAXFL)     **field specification
AA CNLFL*64(MAXFL)      **long names of fields
AA CNSFL*8(MAXFL)       **short names of fields
AA CNUFL*8(MAXFL)       **units of fields
```

3.7 Subdomain Data

```
I MAXSU              maximum number of subdomains
I NSU                **number of subdomains
IA NSUO(3,MAXSU)     **subdomain o element
IA NSUX(3,MAXSU)     **subdomain x element
IA NSUD(3,MAXSU)     **subdomain directions
IA NSUBLK(MAXSU)     **subdomain block number
IA NSUDOM(MAXSU)      **subdomain domain number
IA NSUDS(MAXSU)      **subdomain domain set number
IA NSUTS(MAXSU)      **subdomain time set number
IA NSUFS(MAXSU)      **subdomain field set number
IA NSUPS(MAXSU)      **subdomain plot set number
IA LORSUW(MAXFLS,MAXSU) origin of subdomain workspace storage
IA NDMSUW(4,MAXFLS,MAXSU) dimensions of workspace
IA LORSUN(MAXSU) origin of subdomain node storage
IA NDMSUN(4,MAXSU) dimensions of node workspace
IA NXTPSU(MAXSU) **next primary subdomain
IA NPSU(MAXSU) **primary subdomain of subdomain
```

4 Algorithms

4.1 Initialisation

The initialisation routine DIAINT is called by PIC3D from OUTPUT(1). It loops through the Plots Sets, opens the diagnostic files and writes the headers. It also clears the DIAGWS array. This routine uses the data structure in a top-down manner.

The names of TSD files have the format *run-id-PS-process*.tsd, where *run-id* is the run identification string CHREFN, *PS* is the plot set number and *process* is the process number.

4.2 Data Collection

Data is collected by DIACOL at the subdomain level.

In the first call in each timestep it determines which time sets should have data collected and sets the LCOLTS flags appropriately.

It then loops through subdomains and checks LCOLTS for the appropriate domain to see if data should be collected and it checks if the block containing the subdomain is on the current processor.

If data should be collected for the subdomain it loops through the plots in the plot set and stores the appropriate data in the DIAGWS array using LORSUW(JFL,JSU) as the base address.

4.2.1 Low Level Collection Routines

There is one low level diagnostic routine for each field quantity. The low level routines operate on single subdomains. The routines have names such as IJEDV for collecting $\int \mathbf{j} \cdot \mathbf{E} dV$. The routines may return different amounts of data depending on the nature of the subdomain.

4.3 Data Output

The data output routine DIAOUT is called from OUTPUT(2).

The routine sets the LOUTTS flags to indicate which time sets need output. It then loops through plot sets in a top-down manner combining contributions from subdomains, scaling, writing data and clearing the DIAGWS array.

4.4 Finish

The routine DIAFIN is called from OUTPUT(2) to close any files which may be open.

5 Extensions for GRID Line Plots

The diagnostics have been extended to produce Ghost GRID files containing plots of scalars along a mesh line. These plots are selected by the 'grl' file format. The 'grl' files are named in the same way as 'tsd' files except that the suffix is '.grl'.

5.1 Connections Between Subdomains

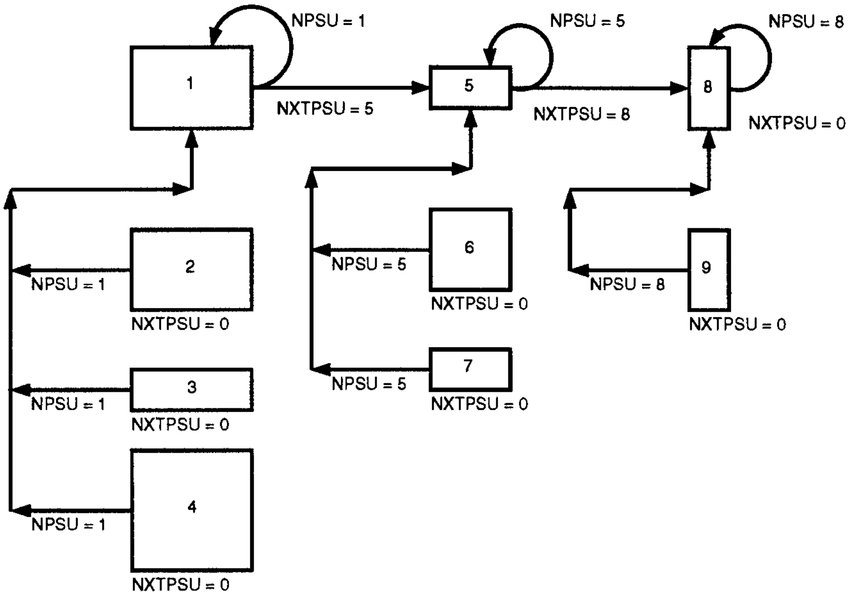

Figure 2: Connections Between Subdomains

Connections between subdomains must be specified to produce line plots. There are two types of connections end-to-end connections and side-to-side connections. The subdomains which are connected end-to-end are called primary subdomains and the other subdomains are called secondary subdomains. The end-to-end connections specify the line along which data is collected. The line goes through the o-points of each *primary* subdomain and goes in the 3-direction within each subdomain. Each secondary subdomain is connected to exactly one primary domain (its 'parent') and the elements in the 2 and 3-directions must match the corresponding elements in the parent primary domain. The secondary domains are required so that the flux through the surface, or the integral along a line, 'perpendicular' to a path, can be plotted against distance along the path.

The first primary subdomain is given by NSUDO$(1,j)$. The variable NXTPSU(i) is used to point to the next primary subdomain. The the last primary subdomain and secondary subdomains have this pointer set to zero. The variable NPSU(i) is used to point from a subdomain to its parent (a primary subdomain is its own parent).

5.2 Plotting parameters

The parameters NCOLDO and NCOLFL are used to specify colours for each domain and each field. The parameters SLIMDO and FLIMFL specify the limits for plotting arc length and field value, SCLDO and SCLFL are used for scaling the arc length and field values.

5.3 Workspace Storage

Workspace storage is contained in the allocated array DIAGWS. Each primary subdomain has storage for arc length for nodes at address LORSUN(i) with upper bounds for the first four array dimensions given by NDMSUN($1:4,i$). (Only the $3,i$ component of NDMSUN($1:4,i$) will differ from 1 for a single line plot). Secondary subdomains do not have storage allocated for arc length to nodes because the values for their parent subdomains are used.

Field values are stored in regions of workspace at address LORSUW(i) with dimensions the first four array dimensions given by NDMSUW($1:4,i$). (Only the $3,i$ component of NDMSUW($1:4,i$) will differ from 1 for a single line plot). All primary subdomains have storage allocated to them for field values but only secondary subdomains on the current process have storage allocated.

5.4 Implementation Notes

- The tsd graphics are a special case of the grl graphics. Only the final output stages need differ.
- The grl graphics readily generalise to plots on surfaces and to plots in volumes.
- Node arrays are one element bigger in each non-trivial direction than field arrays.

References

[1] N J Brealey, *MPICTIM User's Guide*, Culham Laboratory Technical Note, AEA/TYKB/31878/TN10. September 1994.

E MPICTIM User's Guide

AEA/TYKB/31878/TN/10

MPICTIM USER'S GUIDE

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September 1994

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MPICTIM USER'S GUIDE

N J Brealey

September 1994

Abstract

The MPICTIM code is designed to examine time series data produced by PIC simulation codes. It uses an OSF/Motif [1] Graphical User Interface (GUI) instead of the character based interface; this OSF/Motif interface to MPICTIM is much easier than a Command Line Interface (CLI) for interactive use.

1 Using MPICTIM

This Section contains a task orientated description of how to use MPICTIM. Section 2 describes the functions of the different components of MPICTIM. The MPICTIM application uses OSF/Motif Graphical User Interface components. You should refer to your system's documentation for general information on using OSF/Motif. This document concentrates on aspects which are specific to MPICTIM.

1.1 Starting MPICTIM

To start MPICTIM start an `xterm` window and issue the `mpictim` command at the prompt:

```
$ mpictim
```

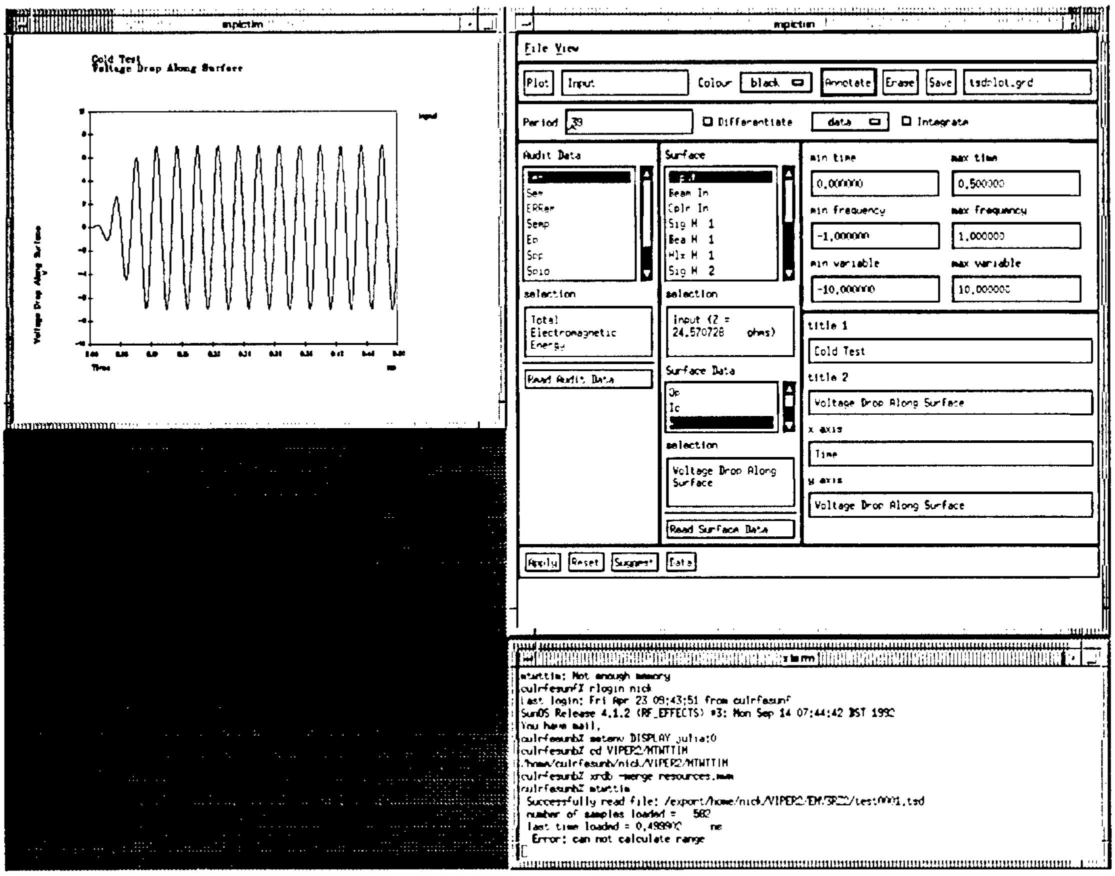
Move and resize the `xterm` window to the lower right of the screen as shown in Figure 1. Your workstation screen should now look like the screen shown in Figure 1. You should consult your system administrator if it looks substantially different.

1.2 Quitting MPICTIM

To quit the application activate the File pull down menu from the menu bar (Figure 2) and select the Exit option.

1.3 Opening Data Files

To open a time series data file activate the File pull down menu from the menu bar (Figure 2) and select the Open option to pop up the Open File dialogue window (Figure 3). Use the Open File dialogue window load a file by selecting



Plot: Input
Colour: black
Save: tsdplot.grd
Period: 39
□ Differentiate
data
□ Integrate

Audit Data: Sem, ERRem, Semp, Ep, Spp, Spio
selection: Total Electromagnetic Energy

Surface: Beam In, Cplr In, Sig H 1, Bea H 1, Hlx H 1, Sig H 2
selection: Input (Z = 24.570728 ohms)

Surface Data: Op, Ic
selection: Voltage Drop Along Surface

min time: 0.000000
max time: 0.500000
min frequency: -1.000000
max frequency: 1.000000
min variable: -10.000000
max variable: 10.000000
title 1: Cold Test
title 2: Voltage Drop Along Surface
x axis: Time
y axis: Voltage Drop Along Surface

```
mpictim: Not enough memory
culrfesunfZ rlogin nick
Last login: Fri Apr 23 09:43:51 from culrfesunf
SunOS Release 4.1.2 (RF_EFFECTS) #3: Mon Sep 14 07:44:42 BST 1992
You have mail.
culrfesunbZ setenv DISPLAY julia:0
culrfesunbZ cd VIPER2/MTMTTIM
/home/culrfesunb/nick/VIPER2/MTMTTIM
culrfesunbZ xrdb -merge resources.mm
culrfesunbZ mpictim
 Successfully read file: /export/home/nick/VIPER2/EM/SP22/test0001.tsd
 number of samples loaded =   582
 last time loaded = 0.499900     ns
  Error: can not calculate range
```

Figure 1: Motif Time Series Analysis Program MPICTIM

a file and activating the OK button. Opening a time series data file replaces all time series data held in the code. If you have sequential data from restart calculations which occupies several files use should use the Append option from the File menu to append data without deleting data which is already loaded.

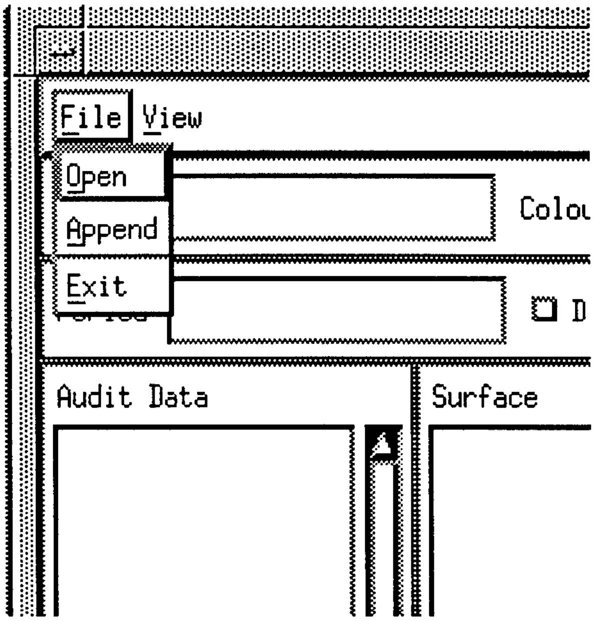


Figure 2: File Menu

1.4 Setting Processing Options

The data processing options are set in the Processing Options area. The options take effect when a data item is selected and either of the Read Audit Data or Read Surface Data buttons are activated.

The period used by the mean, rms, variance and spectrum plots is set by typing text in the Period text field and activating the Apply button at the bottom of the main window.

The Differentiate toggle button enables differentiation of the data before other processing is performed.

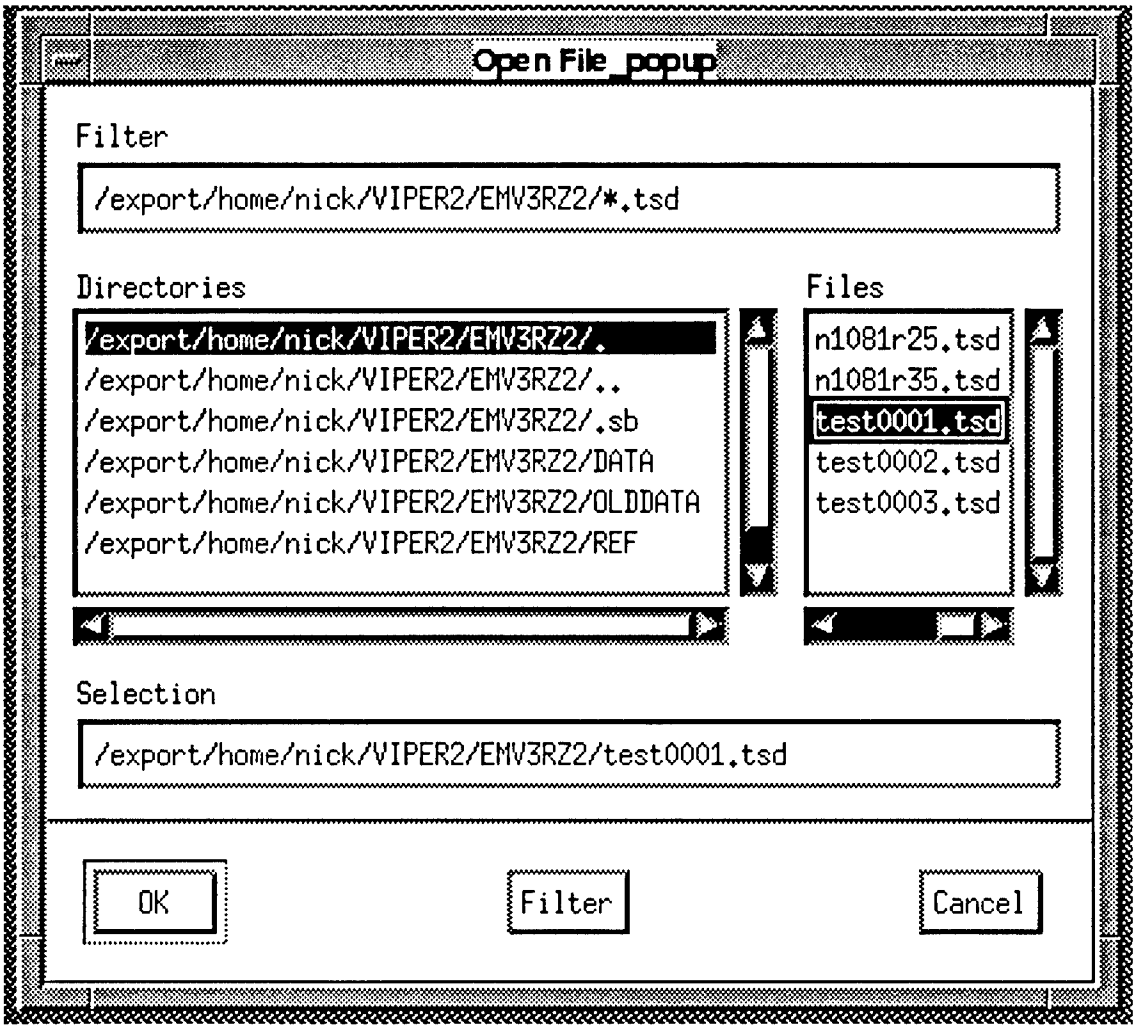
The Processing option menu (Figure 4) allows the user to choose how the data is processed.

The Integrate toggle button enables integration the data after other processing has been performed.

1.5 Choosing the Data to be Processed

To choose the data to be processed select an audit variable from the Audit Data scrolling list or select select a surface and a surface variable from the Surfaces and Surface Data scrolling lists.

Activate the Read Audit Data button or the Read Surface Data button to process the data.



Filter

/export/home/nick/VIPER2/EMV3RZ2/*.tsd

Directories

/export/home/nick/VIPER2/EMV3RZ2/.
/export/home/nick/VIPER2/EMV3RZ2/..
/export/home/nick/VIPER2/EMV3RZ2/.sb
/export/home/nick/VIPER2/EMV3RZ2/DATA
/export/home/nick/VIPER2/EMV3RZ2/OLDDATA
/export/home/nick/VIPER2/EMV3RZ2/REF

Files

n1081r25.tsd
n1081r35.tsd
test0001.tsd
test0002.tsd
test0003.tsd

Selection

/export/home/nick/VIPER2/EMV3RZ2/test0001.tsd

Figure 3: File Selection Dialogue

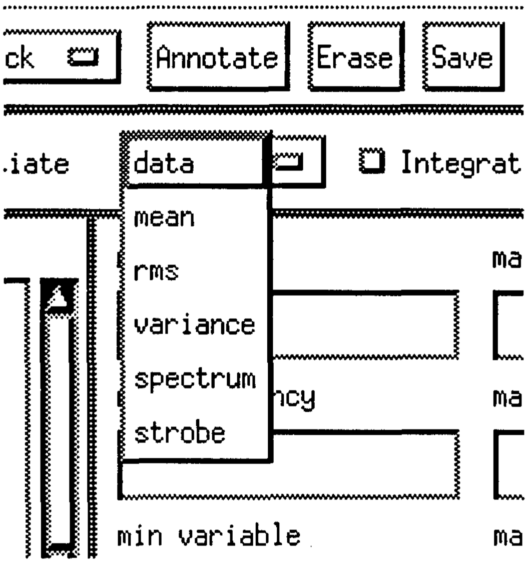


Figure 4: Data Menu

1.6 Producing Plots

The user may select the colour used for plots using the Colour option menu (Figure 5). The plot label is set in the Label next to the Plot button. The user should set the ranges for the plots in the ranges fields. The Apply button at the bottom of the main window must be activated to make the values active. The time range is also used as a window when processing data. The Reset, Suggest and Data buttons at the bottom of the main window may be used to display current ranges, suggested ranges and data ranges (and other parameters).

Once the parameters are set activating the Plot button displays the plot on the screen.

1.7 Annotating Plots

The labels used for annotating the plot are set in the labels text fields. The Apply button at the bottom of the main window must be activated to make the labels active. The Reset, Suggest and Data buttons at the bottom of the main window may be used to display current labels, suggested labels and labels from the data file (and other parameters).

Once the labels are set activating the Annotate button annotates the plot on the screen.

1.8 Saving and Erasing Plots

To save a plot activate the Save button. The plot is saved to a GHOST GRID file [2] with the name given in the text field immediately to the right of the save button.

To erase a plot activate the Erase button.

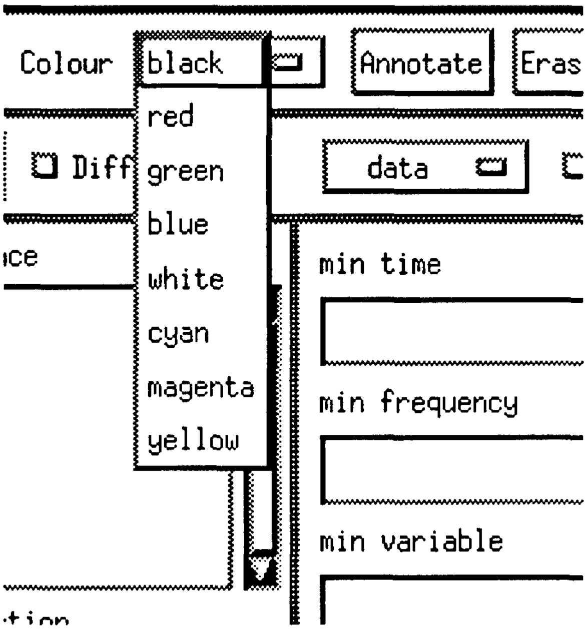


Figure 5: Colour Menu

1.9 Viewing Parameters

Information from the time series data files can be displayed in the window from which MPICTIM was started by activating one of the options from the View pull down menu on the menu bar (Figure 6).

2 Components of MPICTIM

This Section describes the functions of the different components of MPICTIM. Section 1 contains a task orientated description of how to use MPICTIM.

Figure 1 shows the two base windows of the MPICTIM application. The main control window is top right and the graphics display window is top left. The terminal window from which MPICTIM was started is bottom right.

The main control area is shown in greater detail in Figure 7. The components of this window are shown in greater detail in Figure 7 and are described in the following subsections. The components are described in order starting from the top left and scanning from left to right and from top to bottom.

2.1 Menu Bar

The menu bar contains two pull down menus: the File menu and the View menu.

2.1.1 File Menu

The File menu contains three items:

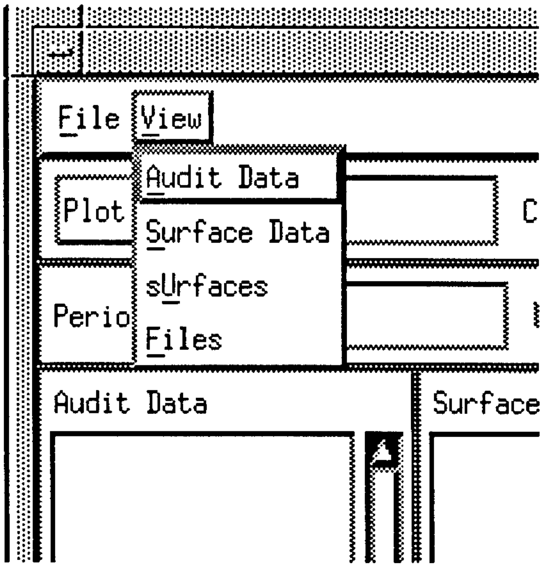


Figure 6: View Menu

Open pops up a file selection dialogue to load data from a time series data file. Loading the data file replaces any data already loaded.

Append pops up a file selection dialogue to append data from a time series data file to data already loaded. The time series data file must contain the same data items and use the same time sampling interval as the files which are already loaded.

Exit quits the application.

2.1.2 View Menu

The View menu is used for displaying information in the window from which MPICTIM was started. The View menu contains four items:

Audit Data displays a list of audit variables. The list gives the variable numbers, the labels, the units used and the long names.

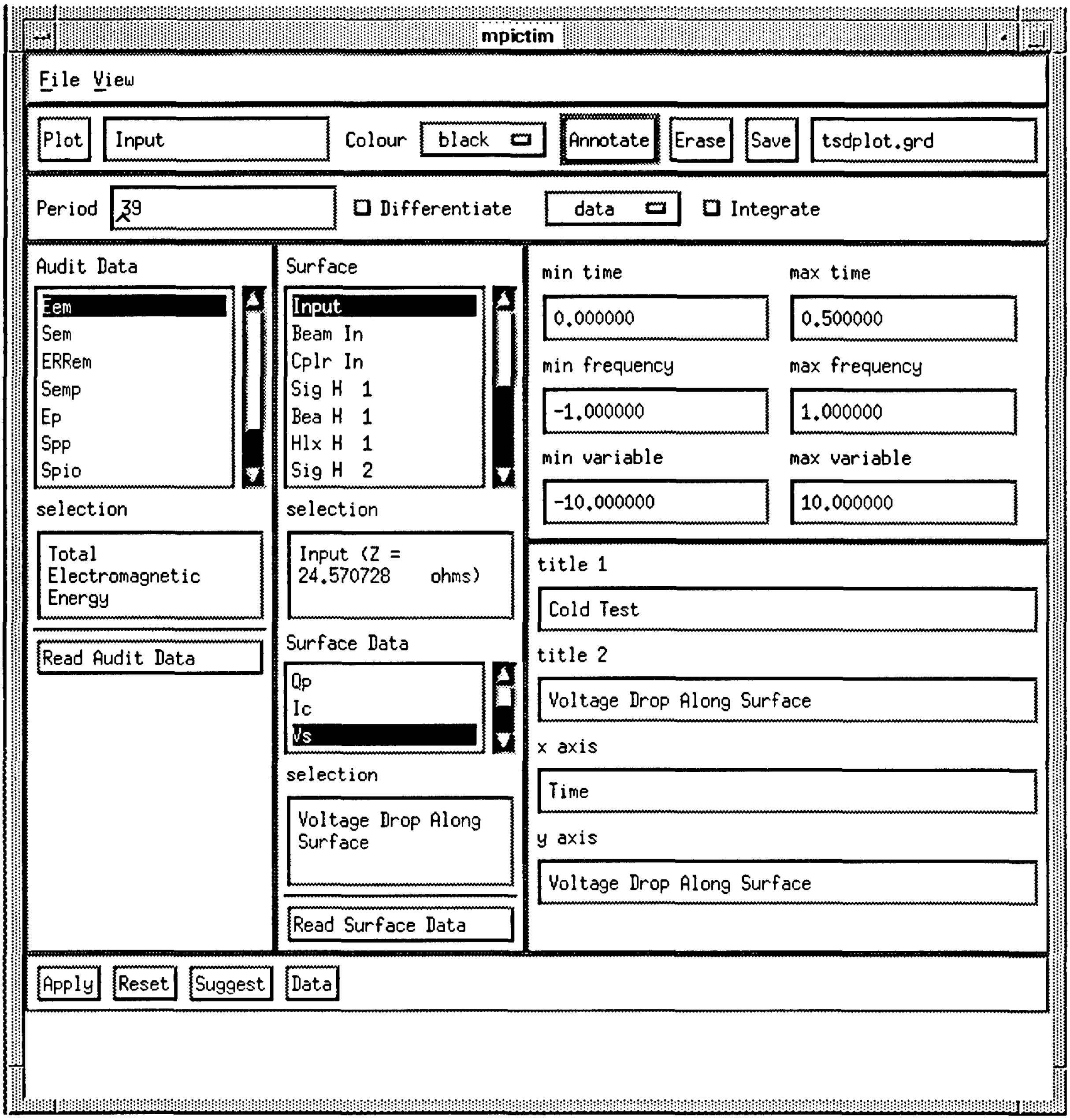
Surface Data displays a list of surface variables. The list gives the variable numbers, the labels, the units used and the long names.

sUrfaces displays a list of surfaces. The list gives the variable numbers, the labels, the default plot colours and the long names.

Files displays a list of the files that have been loaded. The list gives the file name, the run identification string, the sample range in steps, the sample range in units of time, the hinted period in steps and the sampling interval.

2.2 Plot Controls

The plot controls region contains controls used to plot processed data. Working from left to right the controls in this area are:



Input

Colour black

tsdplot.grd

Period 39

□ Differentiate

data

□ Integrate

Audit Data

Eem
Sem
ERRem
Semp
Ep
Spp
Spio

selection

Total Electromagnetic Energy

Surface

Input
Beam In
Cplr In
Sig H 1
Bea H 1
Hlx H 1
Sig H 2

selection

Input (Z = 24.570728 ohms)

Surface Data

Qp
Ic
Vs

selection

Voltage Drop Along Surface

min time 0.000000

max time 0.500000

min frequency -1.000000

max frequency 1.000000

min variable -10.000000

max variable 10.000000

title 1

Cold Test

title 2

Voltage Drop Along Surface

x axis

Time

y axis

Voltage Drop Along Surface

Figure 7: Main Window

2.2.1 Plot Button

Pressing the plot button plots the processed data on the screen using the applied ranges. The plot is labelled with the text from the Label field (immediately to the left of the plot button) and is plotted in the colour set in the Colour option menu.

2.2.2 Label Field

The label field is immediately to the left of the plot button. The text in this field (up to 8 characters) is used as the label for the current curve being plotted. This field may can be made blank if no label is required.

2.2.3 Colour Option Menu

This control sets the colour used to plot a curve. The colour choices are black,red, green, blue, white, cyan, magenta, yellow. (White will not be visible because the background is white).

2.2.4 Annotate Button

This button annotates the plot with the applied labels from the Labels Area. Two title lines and labels for the axes are added.

2.2.5 Erase Button

This button erases the plot.

2.2.6 Save Button

This button saves the plot to a file with the name given in the file name field immediately to the left and erase the plot.

2.2.7 File Name Field

The file name field is immediately to the left of the Save button. It may contain up to 16 characters of text. It specifies the name of the GHOST grid file in which the current plot will be stored. The file is placed in the directory in which MPICTIM was started.

2.3 Processing Controls

This area contains controls which determine how a data item is processed when it is read.

2.3.1 Period Field

This field is used for setting and displaying the period used by the mean, rms, variance and spectrum processing options. The period is set when the Apply button in the Buttons area at the bottom of the application is activated. The hinted period from the data file is shown when the Data button is activated, the suggested period is shown when the Suggest button is activated and the current value is when the Reset button is activated.

2.3.2 Differentiate Toggle Button

When the Differentiate Toggle button is active the data will be differentiated with respect to time before other processing takes place.

2.3.3 Processing Option Menu

This option menu selects the type of processing applied to the data when it is processed. There are six options available:

data is unchanged

mean computed over current period

rms (root mean squared) values computed over current period

variance computed of current period

spectrum computed for time interval truncated to an integral multiple of the current period

strobe plot computed for time interval truncated to an integral multiple of the hinted period

2.3.4 Integrate Toggle Button

When the Integrate Toggle button is active the data will be integrated with respect to the independent variable after other processing has taken place.

2.4 Audit Data Selection Area

This area is used to select an Audit Data item and process it using the current options. The user selects the variable in the scrolling list, the long label is then shown in the selection text field and the data is processed by activating the button labelled “Read Audit Data”. The processed data remains unchanged until another Audit Data item or a Surface Data item is read.

2.5 Surface Data Selection Area

This area is used to select an Surface Data item and process it using the current options. The user selects the surface and the variable in the scrolling lists, the long labels are then shown in the selection text fields and the data is processed by activating the button labelled “Read Surface Data”. The processed data remains unchanged until another a Surface Data item or Audit Data item is read.

2.6 Ranges Area

This area contains text fields for viewing and setting various ranges. The values in the text fields are used to set the ranges when the Apply button in the Buttons area at the bottom of the window is activated. The text fields are set to the current values when the Reset button is activated, they are set to suggested values when the Suggest button is activated and are set to the data ranges (after processing) when the Data button is activated.

2.6.1 Time Range

These text fields may show the time range of the processed data, the suggested time range of the processed data, the current time range or a range which may be applied, depending on which of the Apply, Reset, Suggest or Data buttons have been activated. This interval is used as a data window during the processing of data i.e. data outside the interval is discarded. This interval is also used as the time interval for plots which have time as the independent variable.

2.6.2 Frequency Range

These text fields may show the frequency range of the processed data, the suggested frequency range of the processed data, the current frequency range or a range which may be applied, depending on which of the Apply, Reset, Suggest or Data buttons have been activated. This interval is used as the frequency interval for plots which have frequency as the independent variable. It is also used as the interval for the strobe plots in which data from an interval is processed to produce one period of the signal as a function of time. (For Strobe plots the time axis is in units of the hinted period).

2.6.3 Variable Range

These text fields may show the dependent variable range of the processed data, the suggested dependent variable range of the processed data, the current dependent variable range or a range which may be applied, depending on which of the Apply, Reset, Suggest or Data buttons have been activated. This interval is used as the dependent variable interval for all plots.

2.7 Labels Region

This area contains text fields for viewing and setting various labels used for annotating the plots. The values in the text fields are used to set the labels when the Apply button in the Buttons area at the bottom of the window is activated. The text fields are set to the current values when the Reset button is activated, they are set to suggested values when the Suggest button is activated and values from the data file when the Data button is activated.

Two lines of titles and labels for the x and y axes may be set and viewed.

2.8 Buttons Area

This area contains four buttons which control parameters used by the application:

Apply This button takes the parameters from the Ranges area, the Labels area, the plot label field, the Colour option menu and the Period field and makes the current.

Reset This button resets the Ranges area text fields, the Labels area text fields, the plot label field, the Colour option menu and the Period text field to the current values.

Suggest This button sets the Ranges area text fields, the Labels area text fields, the plot label field, the Colour option menu and the Period text field to the suggested values.

Data This button sets the Ranges area text fields, the Labels area text fields, the plot label field, the Colour option menu and the Period text field to the actual ranges of the data and values from the time series data files.

References

[1] OSF/Motif Programmer's Guide, Revision 1.1, Open Software Foundation, Prentice Hall, ISBN 0-13-640673-4, 1991.

[2] W A J Prior, GHOST USER MANUAL Version 8, UKAEA Culham Laboratory, ISBN 0-85311-184-7, 1991.

F Boundary Conditions for Maxwell's Equations

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BOUNDARY CONDITIONS FOR MAXWELL'S EQUATIONS IN GENERAL GEOMETRY

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BOUNDARY CONDITIONS FOR MAXWELL'S EQUATIONS IN GENERAL GEOMETRY

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September 1994

Abstract

This note derives the conditions that need to be applied to Maxwell's equations in general geometry for certain types of material surface. First general analytic conditions are derived, then their implementation in the PIC3D code is discussed.

1 INTRODUCTION

We are solving Maxwell's equation in 3-D and considering the conditions that need to be applied at a material surface. Let the surface be defined by $\bar{x}^3$ = constant, then $\bar{x}^1$ and $\bar{x}^2$ are the co-ordinates in the surface, sketched in Figure 1.

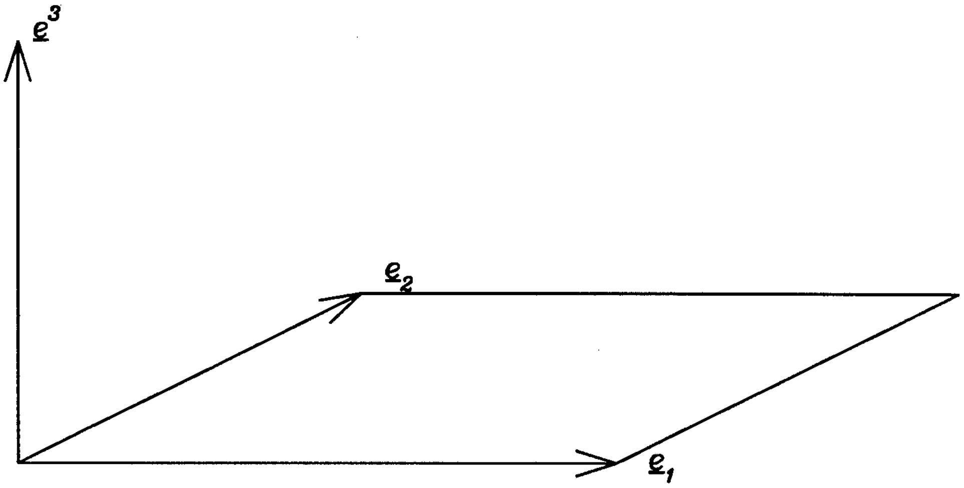

Figure 1: Illustrates the geometry considered when deriving boundary conditions. The vectors $\mathbf{e}_i$ and $\mathbf{e}_2$ lie in the surface which has normal $\mathbf{e}^3$.

First we compile some useful vector identities relevant to such a surface. The third section derives the analytic form of the boundary conditions, and then Section 4 discusses their application in the code. Two main types of boundary are implemented: the resistive wall (of which the perfect conductor is a special case) and one that allows the electric field to be specified on a patch.

2 USEFUL RESULTS

The contravariant basis $\mathbf{e}_i$ is related to the covariant basis $\mathbf{e}^i$ as follows

$$\mathbf{e}_1 \times \mathbf{e}_2 = \mathbf{e}^3 \sqrt{g}, \tag{2.1}$$

$$\mathbf{e}_1 \times \mathbf{e}_3 = -\mathbf{e}^2 \sqrt{g}, \tag{2.2}$$

$$\mathbf{e}_2 \times \mathbf{e}_3 = \mathbf{e}^1 \sqrt{g}, \tag{2.3}$$

$$\mathbf{e}^1 \times \mathbf{e}^2 = \frac{\mathbf{e}_3}{\sqrt{g}} \tag{2.4}$$

$$\mathbf{e}^1 \times \mathbf{e}^3 = -\frac{\mathbf{e}_2}{\sqrt{g}} \tag{2.5}$$

$$\mathbf{e}^2 \times \mathbf{e}^3 = \frac{\mathbf{e}_1}{\sqrt{g}} \tag{2.6}$$

where the volume element

$$\sqrt{g} = [\mathbf{e}_1 \cdot \mathbf{e}_2 \times \mathbf{e}_3]. \tag{2.7}$$

Equations (2.1-2.7) can be used to derive expressions for the tangential part of a general vector $\mathbf{f}$ with components f_i, ie if

$$\mathbf{f} = f_i \mathbf{e}^i \tag{2.8}$$

then the cross product of $\mathbf{f}$ with the vector normal to the surface shown in Fig 1 is

$$\mathbf{e}^3 \times \mathbf{f} = \frac{1}{\sqrt{g}} \{\mathbf{e}_1(-f_2) + \mathbf{e}_2 f_1\} \tag{2.9}$$

or since also

$$\mathbf{f} = f^i \mathbf{e}_i, \tag{2.10}$$

$$\mathbf{e}^3 \times \mathbf{f} = \sqrt{g} \{\mathbf{e}^1(-g^{33}f^2 + g^{23}f^3) + \mathbf{e}^2(g^{33}f^1 - g^{13}f^3) + \mathbf{e}^3(-g^{23}f^1 + g^{13}f^2)\} \tag{2.11}$$

where by definition

$$g^{ij} = \mathbf{e}^i \cdot \mathbf{e}^j. \tag{2.12}$$

There is an important relation which explains how it is possible to define unambiguously $\mathbf{f}_t$, the components of $\mathbf{f}$ tangential to a surface. In Cartesian geometry the expression is

$$\mathbf{f}_t = (\mathbf{n} \times \mathbf{f}) \times \mathbf{n}, \tag{2.13}$$

where $\mathbf{n}$ is the unit vector normal to the surface, and since eq (2.13) is a vector relation it seems that in general geometry the expression should be

$$\mathbf{f}_{t1} = \frac{(\mathbf{e}^3 \times \mathbf{f}) \times \mathbf{e}^3}{\mid \mathbf{e}^3 \mid^2}. \tag{2.14}$$

However, from eq (2.9) is clear that

$$\mathbf{f}_{t2} = (\mathbf{e}^3 \times \mathbf{f}) \times \mathbf{e}_3 = \mathbf{e}^1 f_1 + \mathbf{e}^2 f_2 \tag{2.15}$$

which seems to provide a more satisfactory definition of $\mathbf{f}_t$ since clearly $\mathbf{f}_{t2} \cdot \mathbf{e}_1 = f_1$ etc. However from eqs (2.9) and (2.11) respectively also

$$g g^{33} \mathbf{f}_{t1} = \mathbf{e}_1 (g_{22} f_1 - g_{12} f_2) + \mathbf{e}_2 (g_{11} f_2 - g_{12} f_1) \tag{2.16}$$

$$g^{33} \mathbf{f}_{t1} = \mathbf{e}_1 (g^{33} f^1 - g^{13} f^3) + \mathbf{e}_2 (g^{33} f^2 - g^{23} f^3). \tag{2.17}$$

The equivalence of $\mathbf{f}_{t1}$ and $\mathbf{f}_{t2}$ may be demonstrated by dotting eq (2.17) with $\mathbf{e}_1$ and $\mathbf{e}_2$ respectively. First however, it is worth relating explicitly g^{ij} and $g_{ij} = \mathbf{e}_i .\ \mathbf{e}_j$, viz

$$g^{11} = (g_{22} g_{33} - g_{23}^2)/g, \tag{2.18}$$

$$g^{22} = (g_{11} g_{33} - g_{13}^2)/g, \tag{2.19}$$

$$g^{33} = (g_{11} g_{22} - g_{12}^2)/g, \tag{2.20}$$

$$g^{12} = -(g_{12} g_{33} - g_{13} g_{23})/g, \tag{2.21}$$

$$g^{13} = (g_{12} g_{23} - g_{13} g_{22})/g, \tag{2.22}$$

$$g^{23} = -(g_{11} g_{23} - g_{12} g_{13})/g. \tag{2.23}$$

Using eq (2.17)

$$\mathbf{f}_{t1} \cdot \mathbf{e}_1 = g_{11} f^1 + g_{12} f^2 - \frac{(g_{11} g^{13} + g_{12} g^{23}) f^3}{g^{33}}. \tag{2.24}$$

Since g_{ij} is the inverse of g^{ij}, in particular the (1, 3) entry in their product vanishes, ie

$$g_{11} g^{13} + g_{12} g^{23} + g_{13} g^{33} = 0, \tag{2.25}$$

so eq (2.24) becomes

$$\mathbf{f}_{t1} \cdot \mathbf{e}_1 = g_{11} f^1 + g_{12} f^2 + g_{13} f^3 \tag{2.26}$$

$$= f_1. \tag{2.27}$$

Similarly

$$\mathbf{f}_{t1} \cdot \mathbf{e}_2 = f_2, \tag{2.28}$$

establishing the equivalence of the $\mathbf{f}_{ti}$ in the surface. Note that the expressions are not equivalent in other directions, for

$$\mathbf{f}_{t2} \cdot \mathbf{e}^3 = f^3 - g^{33} f_3, \tag{2.29}$$

$$\mathbf{f}_{t1} \cdot \mathbf{e}_3 = f_3. \tag{2.30}$$

3 ANALYTIC BOUNDARY CONDITIONS

We take Maxwell's equations to be

$$\dot{\mathbf{D}} = \nabla \times \mathbf{H} - \mathbf{J}, \tag{3.1}$$

$$\nabla \cdot \mathbf{D} = \rho, \tag{3.2}$$

$$\dot{\mathbf{B}} = -\nabla \times \mathbf{E}, \tag{3.3}$$

$$\nabla \cdot \mathbf{B} = 0, \tag{3.4}$$

and there are also the volume fields defined as

$$\mathbf{d} = \sqrt{g}\mathbf{D}, \tag{3.5}$$

$$\mathbf{b} = \sqrt{g}\mathbf{B}, \tag{3.6}$$

$$Q = \sqrt{g}\rho, \tag{3.7}$$

$$\mathbf{I} = \sqrt{g}\mathbf{J}. \tag{3.8}$$

The boundary conditions at a wall implied by the source equations (3.2) and (3.4) are easily derived by the standard shrinking pill box argument where $\mathbf{n}$ is replaced by $\mathbf{e}^3/ \mid \mathbf{e}^3 \mid$. Let [f] here denote the jump in a quantity f as a wall is crossed, then (3.4) implies

$$[\mathbf{B} \cdot \mathbf{e}^3] = 0, \tag{3.9}$$

which for reasonable geometries implies that

$$[b^3] = 0 \tag{3.10}$$

or

$$b^3 = b^{ext3} \tag{3.11}$$

and if $\mathbf{B}^{ext}$ is an externally applied field with physical components B(i)

$$b^{ext3} = \sqrt{\frac{g}{g^{33}}}B(3), \tag{3.12}$$

since

$$\mid \mathbf{e}^3 \mid = \sqrt{g^{33}}. \tag{3.13}$$

Similarly, equation(3.2) implies

$$\frac{[\mathbf{D} \cdot \mathbf{e}^3]}{\mid \mathbf{e}^3 \mid} = \rho_s, \tag{3.14}$$

where ρ_s is the surface charge density, ie

$$[d^3] = \sqrt{gg^{33}}\rho_s. \tag{3.15}$$

Next, consider the evolutionary Maxwell's equations, in particular (3.1), since eq(3.3) is of the same form. Integrate (3.1) over a circuit C bounding a surface S that points in the $\mathbf{e}_1$ direction, so that the surface element is

$$d\mathrm{S} = \frac{\mathbf{e}_1}{\mid \mathbf{e}_1 \mid}\epsilon\Delta L \tag{3.16}$$

and the line element

$$d\ell = \frac{\mathbf{e}^3 \times \mathbf{e}_1}{\mid \mathbf{e}^3 \times \mathbf{e}_1 \mid}\Delta L, \tag{3.17}$$

where ϵ is the height of the surface (its extent parallel to $\mathbf{e}^3$) and ΔL is an elementary length. For this circuit

$$\oint_c \mathbf{H} \cdot d\ell = \int_s \mathbf{J} \cdot d\mathbf{S} \tag{3.18}$$

implies

$$-[\mathbf{H} \cdot \mathbf{e}^3 \times \mathbf{e}_1]\frac{\Delta L}{\mid \mathbf{e}^3 \times \mathbf{e}_1 \mid} = \frac{\epsilon J_1}{\mid \mathbf{e}_1 \mid}\Delta L. \tag{3.19}$$

Now using 2.9

$$\mathbf{H} \times \mathbf{e}^3 \cdot \mathbf{e}_1 = \frac{1}{\sqrt{g}}(g_{11}H_2 - g_{12}H_1), \tag{3.20}$$

and the orthogonality of $\mathbf{e}_1$ and $\mathbf{e}^3$ implies

$$\mid \mathbf{e}^3 \times \mathbf{e}_1 \mid = \sqrt{g^{33}g_{11}}, \tag{3.21}$$

hence

$$[g_{11}H_2 - g_{12}H_1] = -\sqrt{gg^{33}}I_{s1}. \tag{3.22}$$

Similarly by considering a circuit bounding a surface pointing in the $\mathbf{e}_2$ direction

$$[g_{22}H_1 - g_{12}H_2] = \sqrt{gg^{33}}I_{s2}. \tag{3.23}$$

Equations (3.22 and 3.23) simplify when $\mathbf{I}_s = \mathbf{0}$ with the consequence that the equivalent analysis for eq (3.3) gives simply

$$[E_1] = [E_2] = 0 \tag{3.24}$$

Equations (3.22 and 3.23) are of little use as they stand, since the surface current is normally specified via the surface Ohm's law

$$\mathbf{e}^3 \times (Z\mathbf{I}_s - \mathbf{E}) = \mathbf{0} \tag{3.25}$$

where Z is the surface impedance. Further manipulations are begun by letting

$$\mathbf{f}_s = Z\mathbf{I}_s - \mathbf{E}. \tag{3.26}$$

By definition of surface current in the geometry considered

$$I_s^3 = 0, \tag{3.27}$$

thus

$$f_s^3 = -E^3 \tag{3.28}$$

$$= \frac{-d^3}{\epsilon_0\sqrt{g}} \tag{3.29}$$

for an isotropic medium with uniform permittivity ϵ_0. Now from eq (2.11), eq (3.25) implies

$$g^{33}f^2 = g^{23}f^3, \tag{3.30}$$

$$g^{33}f^1 = g^{13}f^3. \tag{3.31}$$

Thus

$$I_s^1 = \frac{1}{\epsilon_0 Z\sqrt{g}}(d^1 - \frac{g^{13}d^3}{g^{33}}), \tag{3.32}$$

$$I_s^2 = \frac{1}{\epsilon_0 Z\sqrt{g}}(d^2 - \frac{g^{23}d^3}{g^{33}}). \tag{3.33}$$

Equations (3.32) and (3.33) simplify if either (a) the surface co-ordinates are orthogonal implying $g_{12} = 0$, since from eqs. (2.22), (2.23) and (2.25)

$$\frac{g^{13}}{g^{33}} = -\frac{g_{13}}{g_{11}}, \ \frac{g^{23}}{g^{33}} = -\frac{g_{23}}{g_{22}}; \tag{3.34}$$

or (b) if the 3-coordinate is normal to the surface implying $g_{13} = g_{23} = 0$, since from eqs (2.21) and (2.23).

$$g^{13} = g^{23} = 0. \tag{3.35}$$

Equation (3.24) also cannot be employed as it stands since the boundary electric field is normally specified via a potential difference. In the static case

$$\mathbf{E} = -\nabla\phi \tag{3.36}$$

and if there are no charges on the boundary, which is assumed to have uniform isotropic permittivity ϵ_0, then

$$\nabla \cdot \mathbf{E} = 0. \tag{3.37}$$

Equation (3.36) implies

$$E_i = -\frac{\partial\phi}{\partial\bar{x}^j}, \tag{3.38}$$

which in eq (3.37) yields

$$\sqrt{g}g^{ij}\frac{\partial\phi}{\partial\bar{x}^j} = -C^i \tag{3.39}$$

for some constants C^i, or on multiplying (3.39) by g_{ij}

$$E_j = \frac{C^i g_{ij}}{\sqrt{g}} \tag{3.40}$$

Hence from the definition

$$E_i = \frac{g_{ij}d^j}{\epsilon_0\sqrt{g}}, \tag{3.41}$$

eq (3.40) implies

$$d^i = \epsilon_0 C^i, \tag{3.42}$$

where the C^i follow from the specified potential difference, as will now be illustrated.

Suppose, for example, there is a potential difference only in the 1-direction, then use

$$\frac{\partial\phi}{\partial\bar{x}^j} = -C^i\frac{g_{ij}}{\sqrt{g}} \tag{3.43}$$

to obtain

$$(\phi(A)-\phi(B),0,0) = C^i\int_A^B \frac{g_{ij}}{\sqrt{g}}d\bar{x}^1 \tag{3.44}$$

where A and B are points on opposite boundaries of a patch. Further assuming no normal field ($C^3 = 0$) and surface orthogonal co-ordinates ($g_{12} = 0$) gives $C^2 = 0$ and

$$C^1 = \frac{\phi(A)-\phi(B)}{\int_A^B \frac{g_{11}d\bar{x}^1}{\sqrt{g}}}. \tag{3.45}$$

4 IMPLEMENTATION OF BOUNDARY CONDITIONS

The conditions of applied magnetic and electric field are straightforward given that in the latter case the user is able to calculate the C_i from knowledge of the potential difference, when the condition (3.42) can be directly enforced. The main difficulties arise in the case of resistive walls.

The first point to establish is the relation between I^i employed in the PIC3D code and I^i_s. Integrating over an elementary volume spanned by the vectors $\mathbf{e}_1$, $\mathbf{e}_2$ and $\mathbf{e}_3$ with $\mathbf{e}_1$ and $\mathbf{e}_2$ taken to define the surface, yields

$$\mathbf{I} = \mathbf{I}_s \mid \mathbf{e}_1 \times \mathbf{e}_2 \mid \tag{4.1}$$

$$= \sqrt{g^{33}g}\mathbf{I}_s \tag{4.2}$$

(and similarly for the charge densities Q and ρ_s). Thus from eqs (3.32) and (3.33) the contribution to $\mathbf{I}$ from the resistive wall is

$$I^k = \frac{\sqrt{g^{33}}}{\epsilon_0 Z}(d^k - \frac{g^{k3}}{g^{33}}d^3), k = 1,2, \tag{4.3}$$

assuming (temporarily) pointwise constitutive relationships. Equation (4.3) can be easily expressed in terms of nodal values in either of cases (a) or (b): the second is trivial, and in case (a), $g^{k3}d^3/g^{33}$ can be replaced by

$$\frac{\overline{G^E_{k3}d^3}}{G^E_{(k)(k)}}, \tag{4.4}$$

where the overbar denotes that a four-point average is used to evaluate the numerator. In eq (4.4) the coefficients are needed at points conforming to the standard pattern for G^E_{ij} values, so no special G^E_{ij} calculations are needed.

The PIC3D implementation of the resistive wall update involves the construction

$$d^{k(n+1)} = \alpha d^{k(n)} + \beta \dot{d}^{k(n)} + \gamma, k = 1,2 \tag{4.5}$$

where n, $n+1$ denote time levels, and $\dot{d}^k$ denotes a contribution from $\nabla \times \mathbf{H}$ to the field advance. Using a temporally decentred representation for d^k in (4.3), viz introducting a parameter θ so that

$$\theta d^{k(n+1)} + (1-\theta) d^{k(n)} \tag{4.6}$$

and recalling a factor of $2\Delta t$, it follows that

$$\alpha = \frac{\tilde{Z} + 2\theta - 2}{\tilde{Z} + 2\theta} \tag{4.7}$$

$$\beta = \frac{2\tilde{Z}}{\tilde{Z} + 2\theta} \tag{4.8}$$

and

$$\gamma = \frac{2S_k}{\tilde{Z} + 2\theta} \tag{4.9}$$

where

$$\tilde{Z} = \frac{\epsilon_0 Z}{\Delta t \sqrt{g^{33}}} \tag{4.10}$$

and S_k is the discrete approximation to $g^{k3} d^3 / g^{33}$. Observe that provided $\theta > 1/2$ the above can be used to represent a perfectly conducting wall ($Z = 0$).

G Preprocessor Input Specification

AEA/TYKB/31876/TN/13

THE 3-D GENERAL GEOMETRY PIC SOFTWARE: EXTENDED DESCRIPTION OF INPUTS USED TO GENERATE MESHES

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Contents

THE 3-D GENERAL GEOMETRY PIC SOFTWARE: EXTENDED DESCRIPTION OF INPUTS USED TO GENERATE MESHES

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September 1994

Abstract

Reasons are put forward for preferring the type of interface that we have selected for our mesh generation code. The concepts underlying our approach to mesh generation are outlined, and then a detailed specification is presented. This document supersedes an earlier note issued on this topic [3]

1 Introduction

The complexity of interfaces to existing mesh generation software has led us to produce a simpler interface tailored to the needs of the program under development. The concept underlying our approach is that the device to be modelled is made by joining together 'parts', with appropriate coding to generate the mesh and associated information for each class of part. One important advantage is that 'appropriate' coding could just be that which converts the output of another mesh package into a format consistent with our new software.

For reasons of simplicity and portability, input to our mesh generator takes the form of a file containing text. Previous experience highlights the value of using tags within the file, that take the form of two character words appearing at the start of an item. The tags serve to tell the processor the format of subsequent data. The following discussion indicates the formats that may be required.

First, let us observe that each class of part must have a unique name since it may correspond to a piece of code, which good programming practice implies must be a subroutine. In this case there will be parameters to be set, e.g. the dimensions of a block and the number of mesh-points. Several different parts may belong to the same class, hence some sort of marking is needed to distinguish one part from another. Moreover, there are effectively two sorts of class, not only classes which correspond to subprograms of the mesh software, but also those that are determined dynamically e.g. by reading the output of another mesh generator. Such output may be extremely verbose, hence it is desirable to be able to tell the code to look in a disk file for the data.

The characteristics required of the most general tagged record are thus that it should contain a label, a class name, some way of specifying whether a disk file is to be searched, and then some parameters. Experience again suggests that all but very small sets of parameters are best specified using the NAMELIST format of input. NAMELIST formats are defined as part of the FORTRAN 90 standard [1], and most FORTRAN 77 compilers of which we are aware accept NAMELIST, with slight variations that can be easily corrected for. NAMELIST is not so useful if all parameters in a set have to be specified, hence both NAMELIST and ordinary lists will be permitted. The resulting record structure enables compactness of representation coupled with great flexibility and readability.

The key concepts underlying our approach to mesh generation are further expounded in Section 2. Section 3 describes the three basic input formats required, of which the first or standard is by far the most important. Section 4 contains a detailed specification for input to the mesh generation software, and the final section 5 describes the classes available.

2 Key Concepts

As already mentioned, a device is conceived of being made up of parts. Let us think of a part as relating to a single multiblock or uniblock. For book-keeping purposes it is necessary for every uniblock to have a unique label. However, just as say many cars have four identical wheels, so several uniblocks may correspond to the same part. Defining a uniblock thus involves (i) giving the uniblock a label and (ii) specifying the part to which it relates, by giving the part description.

The part description is composed of two labels, since it is useful to be able to separate the part geometry from the part physics, i.e. to be able to specify permittivities and conductivities etc. independently of the shape of the part. The part physics is specified either by giving a class and associated parameters, or as an entity on disk. The part geometry may be specified similarly.

Having specified the parts, or more precisely the multiblocks, it is necessary to describe how they are put together. If two blocks A and B have a common face, then it is only necessary to give the information that a particular face of block A maps to a face in block B. The convention for labelling faces is indicated in Fig 1 which shows how the labels N, S, E, W, U and D (respectively North, South, East, West, Up and Down) relate to the coordinates used within a block

If blocks only meet over part of a face then it is necessary to specify which fraction of each block's face is involved. Incorporating ideas from ref.[2], connectivity is specified via surface patches. Further, it is helpful to consider the co-ordinate system in which the block maps to the unit cube. (Such a system is obtained by a straightforward contraction from the system proposed in ref.[2]). The unit cube system is then used to measure the extent of the surface patch. The surface patch is specified by giving the face label and co-ordinates of a pair of opposite corners (the 'O' and 'X' points). Note the implication that the patch shape in physical space is effectively determined by the surface in which it lies.

To specify connectivity in the input file, a list rather than a NAMELIST

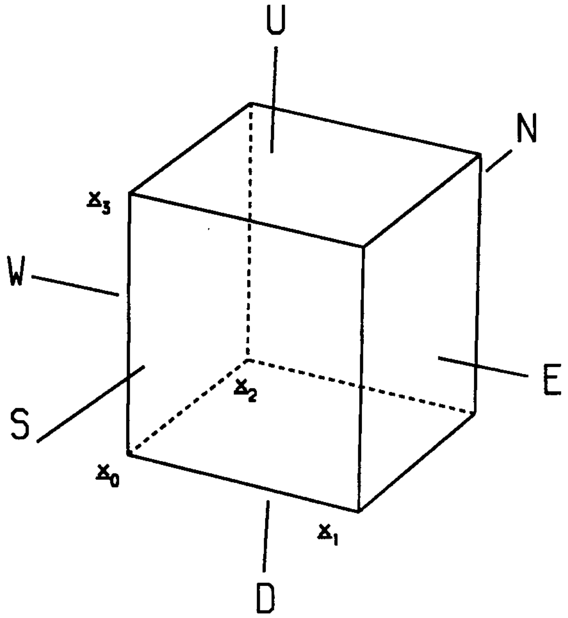

Figure 1: Illustrates the labelling of faces of a multiblock. Position $\mathbf{x}_0$ is the origin of the block co-ordinates and vectors $\mathbf{x}_1$, $\mathbf{x}_2$ and $\mathbf{x}_3$ indicate the 1, 2 and 3 co-ordinate directions respectively.

is appropriate, since we adopt the convention that for each block, connectivity information for every face must appear. Although this implies a factor of two redundancy in the input, since clearly the same patch information appears in the two entries for the adjacent blocks, validation of the input is considerably simplified.

It is desirable also to specify the order in which the parts are assembled. The main reason is the need to determine how many elements are used in each surface patch. It is easy to see that conflicts can occur. For example in Block A there may have to be say 12 × 12 element faces in the face common to Block B, because Block A has been gridded using a foreign mesh generator, but the chosen gridding for Block B might be 16 ×16 × 16 elements. The order of assembly can be used to resolve conflicts by preferring data associated with the block that appears earlier in the ranking. In the example shown, if A appears before B, then the code checks to see whether a 12×12×12 gridding is possible for Block B, which will usually be the case if B is specified as a subprogram class. If B appears before A then the conflict cannot be resolved and an error message should result.

The above example serves to introduce the concept of elastic grid sizes $n_1 \times n_2 \times n_3$ where n_i is the number of elements in a coordinate direction i. For most blocks, the associated n_i are parameters that can be changed to try to resolve conflicts. The convention adopted is that instead of using positive integers for the n_i in these blocks, a negative integer is used for each co-ordinate direction in which the grid size is effectively arbitrary. It is worth noting that even when all blocks have been collected some n_i may remain elastic, and means is provided for defining these. The default is to replace negative n_i by their absolute values, so that in effect negative n_i suggest grid sizes but do not prescribe them.

3 Basic Input Formats

The Section begins by describing the standard tagged input format then goes on to outline other, simpler tagged formats. Detailed specifications for each tag are given in Section 4.

3.1 Standard Format

The standard format of a tagged record as used in Section 4 is written:

```
    QQ␣label␣[howstored=]class␣[par1␣par2...].
```

Labels are case sensitive and should not contain spaces, commas or colons. If the classname contains spaces, these may be replaced by underscore or the entire name should be enclosed in quotes.

To explain the above, note first the convention that items appearing within square brackets are optional. The three compulsory items, each separated by at least one space "␣ ", are QQ which is the generic form for a tag, a label which does not occur in any other record with the same tag, and a classname. An example of such a simple record is:

```
    BG␣part1g␣regular_cubic_lattice
```

This creates a block geometry entry that is referenced by the label *part1g* and described as belonging to the class `regular_cubic_lattice` so that e.g. there exists a subroutine CUBREG to generate the particular geometry.

Parameters that determine *part1g* within the class `regular_cubic_lattice` are specified in subsequent lines of input, using NAMELIST as defined in the standard[1]. Thus the complete entry for *part1g* also includes, e.g.

```
&CUBREG
RXMAX = 0.1, RYMAX = 2.0, RZMAX = 3.0/
```

that specifies the dimensions of the cuboid region (in metres).

The optional entries *par1*, *par2*, ... are special parameters that can be set without recourse to the verbosity of NAMELIST. Their meaning depends on the tag. For BG they are the n_i, in order $i = 1, 2, 3$, defining the grid size. Thus a more complicated entry might be

```
    BG␣part1␣regular_cubic_lattice␣-20␣-60␣-40
```

The use of minus denotes the size is elastic (see Section 2), but that a suggested mesh-size for the part is $20 \times 60 \times 40$ elements.

As its name suggests the optional *howstored* entry indicates how the information is stored. If it is omitted a namelist normally follows as in the example. However other values are possible, depending on the class and tag. All tags allow *howstored* to take the value *file*, indicating the file with the name *class* is to be searched for the remaining information associated with the entry. The file *class* will itself contain an entry of the above form.

Values for *howstored* that may be allowed depending on the tag are *number* and *metric*. *Number* implies that the block geometry is specified as a set of numbers representing e.g. the co-ordinates of mesh-points. *Metric* indicates that the metric information needed for the timestepping calculation is already available. The above serve directly or indirectly to define new classes of geometry.

3.2 List of Labels

There are basically two simpler formats for input. One consists of a tag followed by a list of labels, constituting a complete entry. This is used e.g. to define blocks in terms of predefined block geometries and physics thus

```
    BL␣bl1␣part1g␣part1p
```

and

```
    BL␣bl2␣sameas␣bl1.
```

Note that *sameas* has a special meaning and should not therefore be used as a block label. Any blocks defined without use of a *sameas* can also be thought of as "block types". The same format is used to specify the order of assembly of blocks.

3.3 Connectivity Format

The second simpler input format is used to define connectivities. The tagged line contains only a label (in addition to the tag). Subsequent lines contain the block connectivity information as series of entries (one to a line) in the format:

$$face1[(x_1^{1O},x_2^{1O})(x_1^{1X},x_2^{1X})] = block : face2[(x_1^{2O},x_2^{2O})(x_1^{2X},x_2^{2X})]$$

terminated by a line containing only the tag EN. Omitting the quantities in square brackets is equivalent to taking

$$(x_1^{iO},x_2^{iO})(x_1^{iX},x_2^{iX}) = (0,0)(1,1), i = 1,2.$$

The $\mathbf{x}^{iO}$ and $\mathbf{x}^{iX}$ are the co-ordinates of the 'O' and the 'X' points defining a patch on the face *face1* where $i = 1$ refers to the block of which the label appears on the tagged line and $i = 2$ refers to other blocks, the labels of which appear immediately to the right of the equals sign.

4 Detailed Input Specification

The allowed tags are assigned one of three input formats. The tags BG, BP and PP are used to define respectively the geometry of a block, the physics of a block, and physical data associated with a surface patch (including boundary conditions). The tag DE is used to set default values for parameters, and SF is used to set parameters that otherwise have no associated tag. The input associated with all these tags has the standard format.

The tags BL and PA are used to define respectively a block in terms of its geometrical and physical attributes and a patch in terms of its physical attributes. Tag OR is used to specify the order in which blocks should be connected. The input associated with these tags has the list of labels format.

Lastly the tag BC is used to define block connectivity information. The information in Section 3.3 constitutes a detailed input specification for this tag, thus no further description appears here.

The Table provides a summary of formats for the different tags.

Table 1: Tag Table

Tag	Brief Description	Format+	Special Parameter	Notes*
BC	Block Connectivity	C	-	-
BG	Block Geometry	S	N_1, N_2, N_3	f n m
BL	BLock definition	L	-	3 labels
BP	Block Physics	S	N_1, N_2, N_3	f n m
DE	Defaults (namelists)	S	-	f
OR	ORdering of blocks	L	-	any number of labels
PA	PAtch definition	L	-	3 labels
PP	Patch Physics	S	N_1, N_2, N_3	f n
SF	Set Free parameters	S	-	f

*f, n and m are abbreviations for the allowable *howstored* options *file, numbers* and *metric.*

+S, L and C denote the standard, the list of labels and the connectivity formats respectively

4.1 Tags in Standard Format

4.1.1 BG, BP and PP

Input associated with the tag BG has been specified in Section 3.1. Much the same detailed specification applies to tag BP. The only major differences is that the metric information now relates to permittivity, permeability and conductivity, rather than to position. As might be expected, the associated namelist names also differ. Tag PP input is very similar, with three exceptions, namely (i) that the special parameters are now only n_1 and n_2 since surfaces are two-dimensional, (ii) that it is inappropriate to have direct input of metric terms as a *howstored* option, and (iii) the namelist names are different.

4.1.2 DE and SF

Tags DE and SF have no special parameters and allow *howstored* only to take the value *file.* If *howstored* is not set, then default values are set for variables in the namelist that follows in the case of DE. For SF, depending on *class*, parameters are set that otherwise have no associated tags.

4.2 List of Labels Tags

4.2.1 BL and PA

Tags BL and PA define a multiblock and a surface patch respectively. The format for BL is specified in Section 3.2, and that for PA differs only in that the label following the patch identifier is always *sameas*, thus an example of a record is:

```
PA␣pa1␣sameas␣perfect_conductor1
```

where the patch physics associated with label *perfect_conductor1* has already to have been defined using an item tagged with PP.

4.2.2 OR

The tag OR is followed by a list of block labels in the order of assembly, so that e.g.

```
OR␣blz␣blc␣bla
```

indicates that information associated with block *blz* supersedes information associated with block *blc* which in turn supersedes information about block *bla*. Equivalently think of putting *blz* on the workbench, then attaching *blc* and then *bla*.

5 Class Descriptions

5.1 Block Geometry

5.1.1 Rectbk

This is the name of the base subroutine used to mesh orthogonal geometries, that have either a Cartesian reference coordinate system (MCTYPE = 1), which is the default case, or a cylindrical polar reference coordinate system (MCTYPE = 2). Twelve edge curves defined by discrete points along their length are required to define the block. MTYPE is zero for uniform spacing of the grid in curvilinear coordinates. The variables in NAMELIST *RECTBK* are

MCTYPE	reference coordinate type
MTYPE(3)	input meshtype selector
MDEDGE	dimension of EDGES array
EDGES(MDEDGE)	array of edge curves

5.1.2 Genblk

This is the name of the base subroutine used to mesh nonorthogonal geometries, that have either a Cartesian reference coordinate system (MCTYPE = 1), which is the default case, or a cylindrical polar reference coordinate system (MCTYPE = 2). Twelve edge curves defined by discrete points along their length are required to define the block. MTYPE is zero for uniform spacing of the grid in curvilinear coordinates. The variables in NAMELIST *GENBLK* are

MCTYPE	reference coordinate type
MTYPE(3)	input meshtype selector
MDEDGE	dimension of EDGES array
EDGES(MDEDGE)	array of edge curves

5.1.3 Parallelepiped

A parallelepiped is specified by the lengths of its three sides and the (spherical) polar angles of two of them, the third side being assumed to lie along the polar axis z. The variables in NAMELIST *PIPED* are

RSID1	length of parallelepiped side 1
RSID2	length of parallelepiped side 2
RSID3	length of parallelepiped side 3
THET1	polar angle of parallelepiped side 1
THET2	polar angle of parallelepiped side 2
RPHI1	azimuthal angle of parallelepiped side 1
RPHI2	azimuthal angle of parallelepiped side 2

5.1.4 Polar with regular meshing

This geometry uses a cylindrical polar reference coordinate system. The variables in NAMELIST *POLREG* are

RADINR	inner radius
RADOUT	outer radius
THEMAX	maximum theta (degrees)
AXMAX	maximum along cyl polar-axis

5.1.5 Variable spaced polar lattice

This geometry uses a cylindrical polar reference coordinate system. The variables in NAMELIST *POLVAR* are

RADINR	inner radius
RADOUT	outer radius
THEMAX	maximum theta (degrees)
AXMAX	maximum along cyl polar-axis

5.1.6 Variable spaced cubic lattice

The variables in NAMELIST *CUBVAR* are

RXMAX	maximum along x-axis
RYMAX	maximum along y-axis
RZMAX	maximum along z-axis

5.1.7 Polar mesh segment

The variables in NAMELIST *POLSEG* are

RADINR	inner radius
RADOUT	outer radius
THEMIN	minimum theta (degrees)
THEMAX	maximum theta (degrees)
AXMIN	minimum along cyl polar-axis
AXMAX	maximum along cyl polar-axis

5.1.8 Polar to rectangular transition

The variables in NAMELIST *POLRCT* are

RADCUR	radius of curved edge
RADSTR	radius of straight edge
THEMIN	minimum theta (degrees)
THEMAX	maximum theta (degrees)
AXMIN	minimum along cyl polar-axis
AXMAX	maximum along cyl polar-axis

5.1.9 Regular cubic lattice

The variables in NAMELIST *CUBREG* are

RXMAX	maximum along x-axis
RYMAX	maximum along y-axis
RZMAX	maximum along z-axis

5.1.10 Quadrilateral cylinder

This geometry is the extrusion of a quadrilateral by a length RZMAX. In a plane $z = constant$, the corners of the quadrilateral are in clockwise order: $(0,0)$, $(x1, y1)$, $(x2, y2)$ and $(RYMAX, RXMAX)$. The variables in NAMELIST *QUADRI* are

RXMAX	maximum along x-axis
RYMAX	maximum along y-axis
RZMAX	maximum along z-axis
XQUAD1	x1 point for quadrilateral cylinder
XQUAD2	x2 point for quadrilateral cylinder
YQUAD1	y1 point for quadrilateral cylinder
YQUAD2	y2 point for quadrilateral cylinder

5.2 Block Physics

5.2.1 Uniform

The variables in NAMELIST *UNIFRM* are

EPSR	relative permittivity in uniform block
RMUR	relative permeability in uniform block

5.3 Patch Physics

5.3.1 Perfect conductor, Applied field, Resistive wall and Polar axis

These classes share the same NAMELIST. In the case of an applied electric displacement, the components of field are relative to the coordinates of the block; note that only in some circumstances is **d** constant. STHETA corresponds to θ in the Annex on boundary conditions. The variables in NAMELIST *BCS* are

SURFZ	surface impedance
DAPLYA(3)	applied electric field
STHETA	lagging factor for res. wall bc

5.4 Miscellaneous

5.4.1 Free parameters

This provides the opportunity to designate a specific block to provide the origin of coordinates (using those variables ending in GLB), to set parameters to control a run (NRUN, MDPART, NOPSEL and NXPTDD), to set initial conditions, and to control diagnostic output as described in the Annex on 3DPIC diagnostics. DTMUL is the Courant number C_o in the notation of the Annex on stability and dispersion. MDPART = 1 is needed to prevent the introduction of particles. NINIT corresponds to an initial uniform magnetic field, an initial cylindrical TE mode, a cylindrical TM mode, a rectangular TE mode, a rectangular TM mode or a magnetostatic (PPM) mode, depending whether it takes the values 1, 2, 3, 4, 5 or 6. The field components are set by BUNI and mode parameters are set by variables ending in MODE. Clearly only simple device geometries are allowed, and the 3-coordinate must correspond to z. The variables in NAMELIST *SF* which have not already been described in Ref[4] are

NPAR(MAXPAR)	integer parameter defaults on tagged line
RPAR(MAXPAR)	real parameter defaults on tagged line
CBLGLB*32	block with designated origin and rotation
RFIGLB	spherical phi rotn of named block
THEGLB	spherical theta rotn of named block
XYZGLB(3)	physical position of named block

DTMUL	timestep multiplier
NRUN	number of time steps
MDPART	Dimension of PARTicle coordinate arrays
NOPSEL	Select Output Sequence
NXPTDD	select 0.4 EXPERT diagnostic dump
AMODE(3)	box size for modes
BUNI(3)	uniform initial B
CMODE(2)	mode amplitudes
FMODE	frequency of mode
ZMODE	impedance of mode
NBEXT	use initial B as external B
NINIT	initial field type
NMODE(3)	mode numbers

References

[1] Document ISO/IEC 1539:1991E.

[2] J W Eastwood, R W Hockney and W Arter, *General Geometry PIC for MIMD Computers: Final report*, Report RFFX(93)56, Culham Laboratory, June 1993.

[3] W Arter, *The 3-D General Geometry PIC Software for Distributed Memory MIMD computers: Description of Inputs used to Generate Meshes*, AEA/TLNA/31876/TN/4, January 1994.

[4] N J Brealey, J W Eastwood and W Arter, *3PIC Diagnostics*, Culham Laboratory Technical Note AEA/TYKB/31876/TN9, September 1994.

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BODY-FITTED PIC SOFTWARE FOR MICROWAVE DEVICE MODELLING

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Abstract

This paper describes three dimensional body-fitted Particle-In-Cell (PIC) software for modelling the time evolution of interactions between electromagnetic (EM) fields and flows of relativistic charged particles. A description is given of the physical model, the numerical scheme and the software. The performance achieved by the software on parallel computer architectures demonstrates the potential of this code for large scale time domain electromagnetic and electrodynamic calculations.

1 INTRODUCTION

The software described in this paper offers powerful new capabilities for electromagnetic PIC modelling. It was designed for three dimensional modelling of microwave tubes and microwave transmission where the interaction of electromagnetic waves with charged particle flow is important [1, 2], although it can equally well be applied to other time dependent problems normally tackled by finite difference, time domain (FDTD) codes. Volume filling lossy dielectric, magnetic media, conducting grids and surfaces, surface physics models and external circuit coupling can all be incorporated into the simulations.

It differs from established PIC codes [5, 6, 7, 8] for microwave modelling primarily in that

1. it uses a body fitted finite element net rather than orthogonal finite difference nets,
2. the finite element (FE) derivation gives tensor field equations which carry over the simplicity of the Yee FDTD algorithm [9] for the EM calculation to general geometry nets,
3. the FE derivation gives a charge conserving current assignment scheme on the general geometry nets,
4. it was designed *ab initio* to use a multiblock element net decomposition to use efficiently message passing in distributed-memory parallel computers.

The next section presents the physical model, followed in Section 3 by an outline of the numerical method. Major problems are the description of objects and compact data storage for the computations; these issues are addressed in the Section 4. Parallel computer implementation is treated in Section 5

2 PHYSICAL MODEL

The basic physics involved is well described by Maxwell's equations for the electromagnetic fields and Vlasov's equation (possibly relativistic) for the dynamics of the charged particles. The charged particles may be electrons, ions, or both, although the illustrations given below are for electrons only. The physical model is completed by adding descriptions of the emission and absorption of radiation and of particles from boundaries. In microwave tubes these boundaries may have complex geometries and may be coupled to external circuits. Within the devices may be lossy dielectric and magnetizable materials.

The mathematical model is the relativistic Maxwell-Vlasov set. If the distribution function is represented by a set of sample points (i.e. "superparticles")

$$f(\mathbf{x},\mathbf{p},t) = \sum_i N_s \delta(\mathbf{x} - \mathbf{x}_i(t))\delta(\mathbf{p} - \mathbf{p}_i(t)) \tag{1}$$

where $(\mathbf{x}_i, \mathbf{p}_i)$; $i = [1, N_p]$ are the coordinates of the N_p superparticles, each of mass $M = N_s m_0$ and charge $Q = N_s q$, then the Maxwell-Vlasov set may be written in terms of the action integral

$$I = \int dt d\tau \left(\frac{\mathbf{D}\cdot\mathbf{E} - \mathbf{B}\cdot\mathbf{H}}{2} - \rho\phi + \mathbf{j}\cdot\mathbf{A} \right) - \int \sum_i \frac{Mc^2}{\gamma_i} dt \tag{2}$$

where $\mathbf{B} = \nabla \times \mathbf{A}$ and $\mathbf{E} = -\nabla\phi - \dot{\mathbf{A}}$. Treating I as a functional of the vector potential $\mathbf{A}$, the scalar potential ϕ and particle coordinates $\{\mathbf{x}_i\}$ leads to Euler-Lagrange equations which reduce to Maxwell's equations and the relativistic equations of motion[10].

2.1 Lossy dielectrics

General dielectric and magnetic media may be added to the model by introducing polarisation, $\mathbf{P}$, and magnetisation, $\mathbf{M}$, terms into the action integral

$$I = \cdots + \int dt d\tau (\mathbf{M}\cdot\mathbf{B} + \mathbf{P}\cdot\mathbf{E}) \tag{3}$$

and substituting for $\mathbf{M}$ and $\mathbf{P}$ from the resulting evolutionary equation using their constitutive relationships. The non-lossy part gives the dielectric function relating $\mathbf{D}$ to $\mathbf{E}$, and the lossy parts give the magnetisation and conduction currents, $\mathbf{j}_l$:-

$$\mathbf{D} = \epsilon\mathbf{E}, \;\; \mathbf{j}_l = -\nabla \times \beta\dot{\mathbf{B}} + \sigma\mathbf{E} \tag{4}$$

It has been found advantageous in simulations to use a small magnetisation current to control numerical noise. This allows simulations to be performed with fewer superparticles than would otherwise be possible.

2.2 External Circuits

The full wave description of the microwave tube is linked to a lumped circuit approximation of power supplies and extraction waveguides by coupling elements at the surfaces of the active computational domain to external circuit elements. The external circuit elements have no physical dimension, but they provide a relationship between surface current, I, and tangential electric fields, E. Thus, a purely resistive circuit element would give $E = ZI$ and a circuit with resistance and inductance (or capacitance) would give

$$\alpha\frac{dE}{dt} + \beta E = \gamma\frac{dI}{dt} + \delta I \tag{5}$$

where coefficients $\alpha, \beta, \gamma, \delta$ are chosen to describe the particular external circuit. Similarly, a second order differential equation is used for coupling to an L-R-C circuit and so forth.

2.3 Electron Emission

Electron emission from boundary surfaces is treated using standard Monte-Carlo procedures. Beam injection selects superparticle positions and momenta to fit the incoming beam distribution function. Space charge limited emission at cathodes is modelled by introducing sufficient free surface space charge (in the form of superparticles) to bring the normal field at the surface to zero. Secondary electrons at boundary surfaces are generated and emitted to fit the chosen energy and direction distribution in response to the locations and momenta of impacting superparticles.

3 NUMERICAL METHOD

The discrete equations are obtained using the virtual particle method [4], with fields in the general geometry version being represented by their tensor components. These components are approximated by finite elements in both space and time, and the distribution functions are represented by sets of sample points ('superparticles'). The finite element and sample approximations are substituted into the action integral, whence variations with respect to potentials lead to discrete forms of Maxwell's equations and prescriptions for charge and current assignment. Current is assigned from 'virtual particles' placed at points specially interpolated between positions at successive time levels, a procedure which automatically leads to charge conservation. In all cases, we have assumed the lowest order conforming elements.

In general curvilinear coordinates $(\bar{x}^1,\ \bar{x}^2,\ \bar{x}^3)$ the Action integral is

$$I = \int dt\ d\bar{x}^1\ d\bar{x}^2\ d\bar{x}^3 \left\{\frac{1}{2}(E_i\ d^i - H_i\ b^i) + I^i\ A_i - Q\phi\right\} \tag{6}$$

where

$$E_k = -\frac{\partial\phi}{\partial\bar{x}^k} - \frac{\partial A_k}{\partial t}, b^i = \epsilon^{ijk}\frac{\partial A_k}{\partial\bar{x}^j} \tag{7}$$

$$d^i = \epsilon_o\sqrt{g}g^{ij}E_j, H_i = \frac{1}{\mu_o\sqrt{g}}g_{ij}b^j \tag{8}$$

The 'superparticle' current is given by the sum over all particles:

$$I^i = \sum_p q_p\delta(\bar{x}^1 - \bar{x}^1_p)\delta(\bar{x}^2 - \bar{x}^2_p)\delta(\bar{x}^3 - \bar{x}^3_p)\dot{\bar{x}}^i \tag{9}$$

3.1 Field Equations

Treating Action I as a function of the finite element approximations for ϕ and A_i, then taking variations with respect to the nodal amplitudes gives the element contributions to the discrete approximations to Maxwell's equations. In general, the form of the assembled equations depends on the number of elements and boundaries adjacent to the node in question. However, for an internal node where the element net is topologically equivalent to a cubic lattice, the assembled equations take the familiar form:

$$\partial_t \mathsf{b}^i = -e^{ijk}\partial_j \mathsf{E}_k, \quad \partial_i \mathsf{b}^i = 0 \tag{10}$$

$$\partial_t \mathsf{d}^i = e^{ijk}\partial_j \mathsf{H}_k - \mathsf{I}^i, \quad \partial_i \mathsf{d}^i = Q \tag{11}$$

where the symbol ∂ denotes a centred difference. These equations in tensor quantities b^i,d^i, E_k,H_k,I^i and Q take the same form as the Yee FDTD scheme [9] for cartesian field components, but *are identical in any coordinate system.* This provides great simplification.

3.2 Constitutive Equations

Geometrical and material (permeability and permittivity) information appears only in the constitutive relations. The weak approximations to Eqs (8), with lumped mass matrices give the simplest explicit expressions for E_i and H_i of the form:

$$\mathsf{E}_i = \mathsf{G}^E_{ij}\mathsf{d}^j; \quad \mathsf{H}_i = \mathsf{G}^H_{ij}\mathsf{b}^j \tag{12}$$

Elements of the symmetric tensors G^E_{ij} and G^H_{ij} are sparse matrices. More general permittivities and permeabilities are handled by replacing ϵ_0 and μ_0 by scalar or tensor functions in the computation of G^E_{ij} and G^H_{ij}, respectively.

3.3 Assignment

The formulae for current and charge assignment arising from the variational formulation are also coordinate independent. Let the finite element test function approximations to the potentials be $\phi = \Phi U$ and $\mathsf{A}_i = A_{(i)}W_{(i)}$, where Φ and A are nodal amplitudes, and sums are implied over element nodes (cf Ref [4]). Then variations of Eq(6) yield:

$$\text{charge assignment}: \quad Q \quad = \quad \int dt \sum_p q_p U((\bar{x}^1_p,\ \bar{x}^2_p,\ \bar{x}^3_p)(t), t) \tag{13}$$

$$\text{current assignment}: \quad I^i \quad = \quad \int dt \sum_p q_p \dot{\bar{x}}^{(i)}_p W_{(i)}((\bar{x}^1_p,\ \bar{x}^2_p,\ \bar{x}^3_p)(t), t) \tag{14}$$

In two dimensions, the integrals for Q and I^i are evaluated in exactly the same manner as described in Ref [4]. The only difference is that the cartesian coordinates (x, y) are replaced by the curvilinear $(\bar{x}^1, \bar{x}^2)$. This generalises straightforwardly to three dimensions, but then requires assignment from two rather than one 'virtual particle' per segment per element to ensure exact charge conservation.

3.4 Charge Conservation

Charge and current assignment are linear operations, so by linear superposition, conservation for one trajectory moving through a single time step implies the same for the sum of all trajectories. Summing all contributions to currents from a single particle, gives the same as the difference of charge at start and end times, ie the linear quadrilateral (hexahedral in three dimensions) element case satisfies

$$\partial_t Q = -\partial_k I^k \tag{15}$$

where the symbol ∂ denotes a centred difference arising from assembling the finite element contributions, and Q and I^k are nodal amplitudes. Equations of the form (15) can be shown to be generally satisfied for VP algorithms.

3.5 Particle Dynamics

Particle equations of motion are integrated by first updating the curvilinear momentum components, $\bar{p}_k^{n-1/2}$ measured at the current particle positions $\bar{x}^{k,n}$ using

$$\bar{p}_k^{n+1/2} - \bar{p}_k^{n-1/2} = q\Delta t(\bar{E}_k^n + e_{klm}(\bar{v}^{l,n-1/2} + \bar{v}^{l,n+1/2})\bar{b}^n/2 \tag{16}$$

where $\bar{v}^l$ are contravariant velocity components and e_{klm} is the permutation symbol. The Christoffel symbol term does not appear as Eq(16) is evaluated at a fixed position.

Positions are updated to new timelevel $n+1$ and the momentum components at the new positions are computed using a predictor-corrector scheme on

$$\bar{x}^{k,n+1} - \bar{x}^{k,n} = \bar{v}^{k,n+1/2}\Delta t \tag{17}$$

and

$$\bar{p}^{l,n+1/2}(\bar{x}^{n+1}) = \mathbf{e}^l(\bar{x}^{n+1}) \cdot \mathbf{e}_k(\bar{x}^n)\bar{p}^{k,n+1/2}(\bar{x}^n) \tag{18}$$

In cartesians, this scheme reduces to the usual Lorentz force leapfrog integration scheme [11].

4 SOFTWARE STRUCTURE

The problem in designing the software is to devise a scheme where complex shaped objects can be simulated efficiently on a distributed memory parallel computer. The solution we have adopted is to divide the object being modelled into a set of curvilinear hexahedral blocks, where each block is equivalent to a cube. Each block has its own fields and particles and communicates with other blocks and boundaries only via its patch buffers.

Global data describes the location and logical connection of the blocks, and is common to all the processors on which the program resides. Local data describes fields and particle coordinates, and is different in each processor's copy of the program. If blocks reside on the same processor, their patch data is exchanged by memory to memory copies, but if they are on different processors, message passing is used.

Data initialisation is performed as follows: A device is specified by compact descriptions of the building blocks, their connectivity, and the boundary condition patches on surfaces. Input validation checks that the surface of every block is completely covered by patches and that the connections are physically realisable. Restricting boundary conditions to block surfaces greatly simplifies their application, but does not constrain load balancing. Several blocks may be assigned to one processor, or larger blocks may be subdivided to balance loading across processors.

The volume within each block is subdivided into a lattice of elements using transfinite interpolation [12]. In the curved space in which the equations are solved, the lattice becomes a rectangular brick of cubical elements, leading to simple addressing and fast code. We use a data compression scheme which makes the storage needed for basis vectors and metrics negligible for most blocks.

5 PARALLEL PERFORMANCE

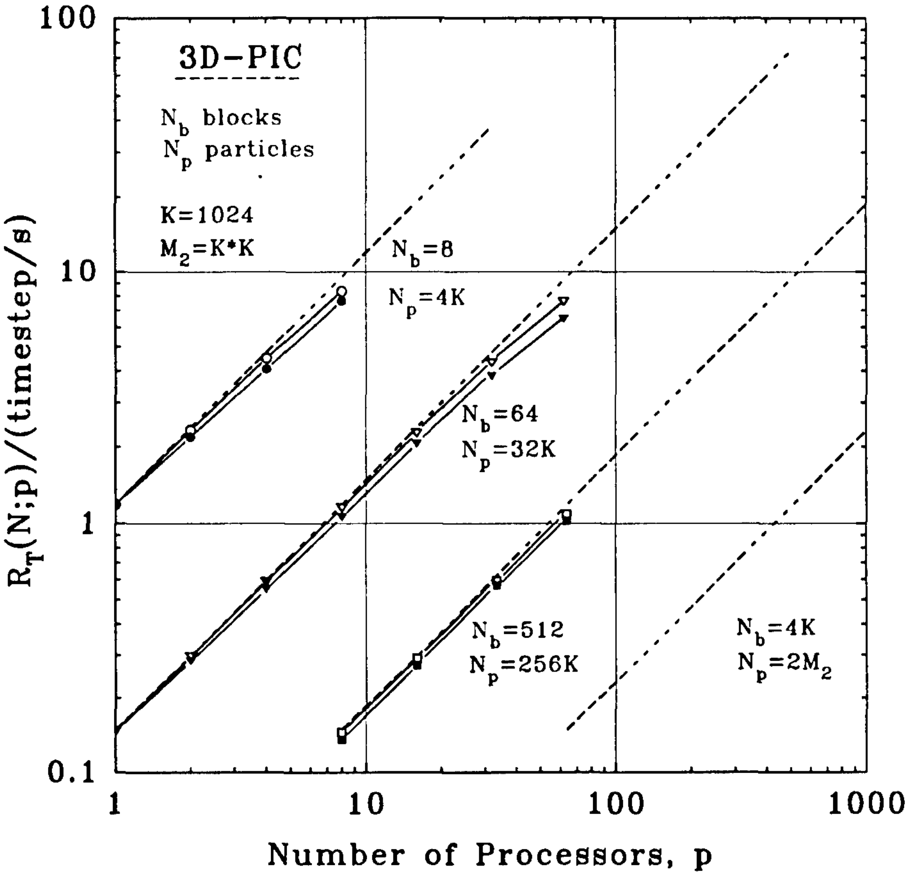

Figure 1: Temporal performance of the MIMD PIC code for three problem sizes as a function of the number of processors used, on a 16 processor Intel iPSC/860. Solid symbols are for per-patch code, open symbols for per-processor code. The dotted lines are the theoretical ideal behaviour scaled from the one-processor performance for the 8-block case.

The message passing model used in our program matches the structure of the new generation of massively parallel processors (MPPs) such as the Intel Paragon and Meiko CS-2, and is also implemented efficiently on the traditional parallel vector shared-memory computers such as the Cray Y-MP and C-90. Our code currently uses the Intel NX/2 library of communication subroutines (mostly CSEND and CRECV) because these are implemented with minimum overhead on many computers and are widely used. Conversion of the code to PVM [13] or the emerging MPI standard [14] should be straight forward since message-passing calls are confined to a few subroutines. We did not use PVM for our implementation because of the very high startup time for message send on most implementations [15].

Both two and three dimensional test cases have been used to evaluate parallel performance. Shown in figure 1 are measurements for three sizes of three dimensional electron plasma calculations run using up to 64 processors on an Intel iPSC/860. Cubical plasma computations comprising 8, 64 and 512 blocks of 64 elements were used. Each block was initialised with 512 particles. For each problem size the performance is measured for a variety of numbers of processors in order to test the scaling behaviour. We measure the performance using an absolute performance metric, namely the Temporal performance [17] expressed in units of timestep per second (tstep/s), because this is the figure of merit that the user of any simulation program wishes to maximise.

Two performance curves are given: the solid symbols show the results for the per-patch code which sends a separate message for each glue-patch, whilst the corresponding open symbol shows the better performance that is obtained if the patch messages are combined so as to send only a single multi-patch message between each pair of connected processors, the per-processor code. The smallest 8-block problem can only use 8 processors at the most (one block per processor), and all possible points are measured and shown. The increase of performance with number of processors is very close to the ideal linear rise proportional to the number of processors, which is shown by the dotted line rising at 45 degrees. Ideally, not only do we aim to achieve 'p' times the performance of a single processor on a given problem when using p-processors, we also hope to be able to solve a problem that is 'p' times bigger in the same time. The other dotted ideal performance lines express this relation, and are scaled from the one-processor point for $N_b = 8$. The measured results for the per-processor code for the other two problem sizes follow this scaling relationship almost exactly. In fact, the worst Efficiency (percentage deviation from the ideal dotted lines) for the per-processor code is 76%, which is seen for the 64-block case on 64 processors. We may conclude therefore that the scaling performance of the code is good up to 64 processors. We anticipate similar scaling to be maintained for larger problems and the larger number of processors available on the Intel Paragon.

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Electromagnetic Modelling in Arbitrary Geometry by PIC Methods on MIMD Computers

by

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ABSTRACT

A relativistic electromagnetic PIC algorithm for general three dimensional geometries is described. The correct combination of co- and contravariant field components and of weighting yields simple coordinate invariant numerical prescriptions. The use of isoparametric hexahedral elements, generated by transfinite interpolation, and multiblock decomposition leads to algorithms ideally suited to MIMD computers, as demonstrated by the speedup obtained on an iPSC/860.

1 Introduction

Virtual Particle (VP) particle-mesh algorithms are now established as an effective approach to obtaining numerical schemes for solving the relativistic Maxwell-Vlasov equations [1, 2, 3, 4]. Unlike conventional Particle-in-Cell (PIC) schemes, they are derived using finite elements in both space and time. Current is assigned from 'virtual particles' placed at points specially interpolated between positions at successive time levels, a procedure which automatically leads to charge conservation. Existing VP implementations use rectangular finite elements in two dimensional Cartesian and polar geometries. Only a restricted class of device is well modelled in such circumstances, leading to the need to implement VP in more complex geometries. Section 2 of this paper shows how the VP method extends to general three dimensional body-fitted elements [5], whilst Section 3 explains how blocks of these elements are assembled to model realistic devices, and shows the speedup achievable on distributed Memory MIMD architecture computers.

2 Variational Formulation

In general curvilinear coordinates $(\bar{x}^1,\ \bar{x}^2,\ \bar{x}^3)$ the action integral may be written

$$I = \int dt\ d\bar{x}^1\ d\bar{x}^2\ d\bar{x}^3 \sqrt{g} \left\{ \frac{1}{2}(E_i\ D^i - H_i\ B^i) + j^i\ A_i - \rho\phi \right\} + I_K \tag{1}$$

where I_K is the kinetic Lagrangian and

$$E_k = -\frac{\partial \phi}{\partial \bar{x}^k} - \frac{\partial A_k}{\partial t} \tag{2}$$

$$B^i = \frac{\epsilon^{ijk}}{\sqrt{g}}\frac{\partial A_k}{\partial \bar{x}^j} \tag{3}$$

$$D^i = \epsilon_o E^i = \epsilon_o g^{ij} E_j \tag{4}$$

$$H_i = \frac{B_i}{\mu_o} = \frac{1}{\mu_o} g_{ij} B^j \tag{5}$$

If we further assume that the distribution function is represented by a set of sample points (ie 'superparticles'), then the source terms in the field Lagrangian become

$$j^i = \sum_p \frac{q_p}{\sqrt{g}} \delta(\bar{x}^1 - \bar{x}^1_p)\delta(\bar{x}^2 - \bar{x}^2_p)\delta(\bar{x}^3 - \bar{x}^3_p)\dot{\bar{x}}^i \tag{6}$$

$$\rho = \sum_p \frac{q_p}{\sqrt{g}} \delta(\bar{x}^1 - \bar{x}^1_p)\delta(\bar{x}^2 - \bar{x}^2_p)\delta(\bar{x}^3 - \bar{x}^3_p) \tag{7}$$

and the kinetic Lagrangian term becomes

$$I_K = -\int dt \sum_p \frac{Mc^2}{\gamma_p} \tag{8}$$

The sums in p are over particles, each with charge q_p. The metric tensor elements g_{ij} can be computed from the relationship between Cartesian and the general curvilinear coordinates i.e. given

$$x^i = x^i(\bar{x}^1,\ \bar{x}^2,\ \bar{x}^3) \tag{9}$$

then

$$g_{ij} = \frac{\partial x^s}{\partial \bar{x}^i}\frac{\partial x^s}{\partial \bar{x}^j} \tag{10}$$

where $g = ||g_{ij}||$ and $g_{ij}g^{jk} = \delta^k_i$. Treating I as a functional of the vector potential A_i, the scalar potential ϕ and particle co-ordinates $\{\mathbf{x}_p\}$ leads to Euler-Lagrange equations representing Maxwell's equations and relativistic particle motion.

Substituting test function approximations for ϕ, A_i and $\mathbf{x}_p$ and varying with respect to the nodal amplitudes yields a finite element approximation to the Maxwell-Vlasov equations. Now, if we introduce $b^i = \sqrt{g}B^i$, $d^i = \sqrt{g}D^i$, $J^i = \sqrt{g}j^i$ and $Q = \sqrt{g}\rho$, Maxwell's equations become

$$\frac{\partial b^i}{\partial t} = -e^{ijk}\frac{\partial E_k}{\partial \bar{x}^j},\quad \frac{\partial b^i}{\partial \bar{x}^i} = 0, \tag{11}$$

$$\frac{\partial d^i}{\partial t} = e^{ijk}\frac{\partial H_k}{\partial \bar{x}^j} - J^i,\quad \frac{\partial d^i}{\partial \bar{x}^i} = Q, \tag{12}$$

where e^{ijk} is the permutation symbol. This suggests, and our analysis confirms, that the discrete VP equations in the quantities b^i, d^i, E_i, H_i, J^i and Q are identical in any co-ordinate system. Geometrical information appears, along with the permeability and permittivity tensors, only in the constitutive relations relating **H** to **B** and **D** to **E**.

3 Mesh Generation and MIMD

A general curvilinear coordinate system arises naturally when we seek to represent awkwardly shaped devices. Transfinite interpolation provides a coordinate system for any simply connected surface (in 2-D) or volume (in 3-D) provided the bounding curves or surfaces are not too convex or concave. Realistic microwave sources involve cavities and waveguides of cylindrical and rectangular cross-section. Separate subdomains or blocks are therefore introduced to handle the various components and also axial effects.

The multiblock subdivision of the computational domain minimises the amount of global data and interprocessor message passing, and simplifies load balancing across processors. Each slave block only requires data from its neighbours, and the master control program only requires information about the block surfaces ('glue patches') which join the slave blocks together. This arrangement offers the prospects of large computational intensity and a weak Amdahl limit to speedup on distributed memory MIMD computers. Moreover, the simple logical cube addressing within each block leads to fast serial processing.

We can further demand that boundary conditions *only* apply at the surfaces of blocks; this eliminates the addressing problems in embedding surfaces within blocks, and allows surface data to be passed to the control program through the 'glue patch' tables. Further saving of computer storage and time arise from keeping metric information and material property data only in those blocks where they are needed. When many small blocks are used to describe a complex object, load balancing is achieved by assigning several blocks to one processor.

3.1 Test Problem

Figure 1 shows results obtained using an iPSC/860 hypercube for a small test problem involving a planar MILO configuration. The device is modelled using 20 multiblocks that contain either 192 or 128 elements; the total number of particles employed is under 5000. The run is chosen to reflect the general characteristics of a production calculation, except that it is terminated after only a few (100) timesteps. It also differs from the normal MILO runs in that the device is initially filled with a nonzero electric and magnetic field. The outcome is that electrons are emitted from the whole length of the cathode, and there is a strong initial transient where the electrons fill only part of the device volume.

The results of this and similar benchmark computations show encouraging speedup, even for modestly sized calculations. Over 80% ideal linear speedup is achieved even for very non-uniform electron distributions, cf. Figure 1. The present implementation bases message passing on a patch to patch basis. On machines with high interprocessor message passing latency, further speedup would result from presorting the patches and performing message passing on a processor by processor basis.

4 Final Remarks

Our preliminary VP benchmark computations support the contention that the multiblock decomposition allowed by these algorithms is ideal for distributed memory MIMD computers.

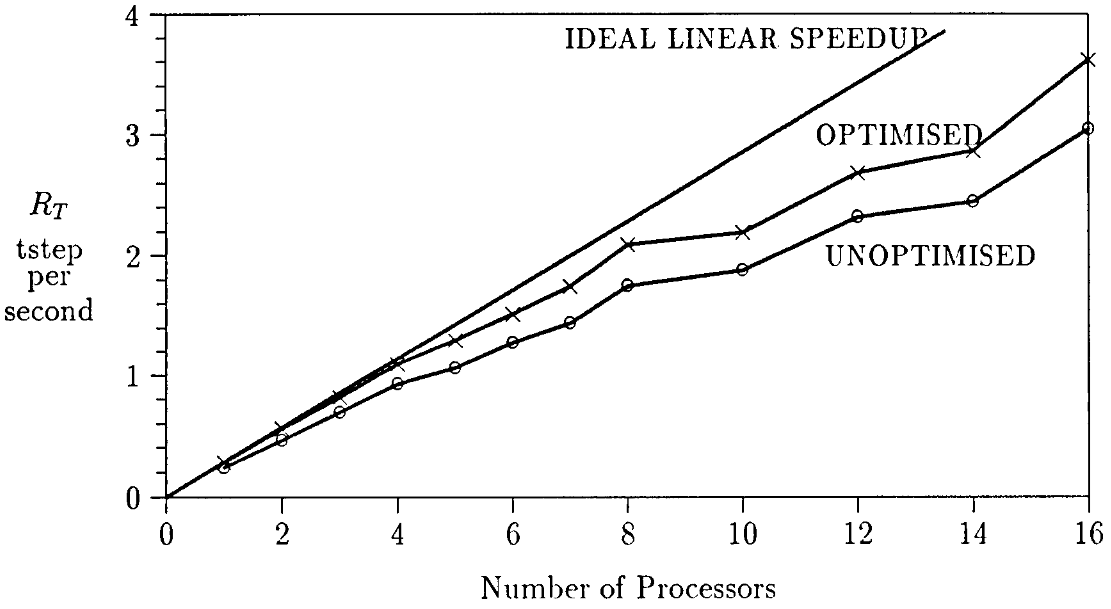

Figure 1: Temporal Performance in timesteps per second (tstep/s)

The electromagnetic calculation can be statically load balanced, has little message passing between blocks and small scalar overheads.

We are currently developing general geometry software based on the scheme described herein in order to extend our capability for microwave tube modelling. However, the elegant body-fitting electromagnetic solver part of our PIC scheme can equally well be applied to the computationally simpler problems where free charges are absent; for example, to study waveguides and exterior scattering problems.

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